SCIENTIFIC AMERICAN
No. SUPPLEMENT 372

Scientific American Supplement, Vol. XV., No. 372. | NEW YORK, FEBRUARY 17, 1883. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

THEORIES REGARDING POLAR AURORAS.

THERE are few phenomena that have given rise to so great a number of hypotheses and theories as has the polar aurora, and an entire volume might be filled by citing them, without even discussing them. So we shall not attempt a historic examination of these opinions, but limit ourselves solely to setting forth the principal theories, especially those which have exerted the most influence upon the study of the subject. Such theories may be relegated to four distinct classes: cosmic, optical, magnetic, and electrical.

COSMIC THEORIES.

In the cosmic theories, the aurora is made to proceed from causes entirely external to our globe. Of the numerous theories of this nature, the one that has had most celebrity is that of Mairan, who wrote his whole "Treatise on the Aurora Borealis" in order to explain and defend it. This author attributes all polar auroras to the zodiacal light, a whitish glimmer resembling that of the Milky Way, and which exhibits itself in the heavens at certain times of the year under the form of a very elongated spindle, extending along the zodiac. The first serious studies on this phenomenon were made by Cassini, beginning with 1683. These were continued notably by Mairan, and it was acknowledged that, according to all appearances, the zodiacal light was a sort of much flattened ring, formed of material particles, and surrounding the solar equator. The radius of this ring, variable with the time, is always very great, and may sometimes even reach or exceed that of the terrestrial orbit.

According to Mairan, the aurora borealis is produced when the matter of the zodiacal light, ceding to the attraction of the earth, falls into our atmosphere and inflames therein, "either of itself or through its collision with the particles of the air, or through the fermentation that the mixture of the air causes." Starting from this hypothesis, Mairan explains in quite an ingenious way the different appearances and the periods of the aurora borealis.

This hypothesis appears to have been adopted at that epoch with very great enthusiasm. According to Fester, Mairan "lighted a torch which illumined the origin and causes of the phenomenon." In his treatise on meteorology, Cotte speaks "of the admirable concordance that exists between all the parts of this system and the result of the observations that a table of the auroræ borealis presents to us."

From nearly its very origin, however, there had been made to Mairan's hypothesis an unanswerable objection, and that was that if the aurora borealis has no connection with the atmosphere, it ought to possess an apparent motion from east to west, like the other celestial bodies. A discussion of all the observations at Bossekop led Bravais to opposite conclusions; not only that motions from east to west do not prevail in the polar aurora, but that, on the contrary, it is the opposite motion that is most frequent. In a like manner, the motion of the earth in its orbit manifests itself in no wise in the motions of the aurora. Besides this, a cosmic origin cannot explain the so regular diurnal variations that are observed in the succession of the aurora's forms. "These remarks," concludes Bravais, "seem to me to ruin any hypothesis that would attribute the aurora borealis to a cosmic matter of origin foreign to our globe. How explain by such a hypothesis the so evident diurnal period that the *forms* of the aurora follow, and the absence of all similar period in the *motions*? How can we understand that the diurnal variation can be found again where it should not exist, and that it should be where it ought, on the contrary, not to exhibit itself?"

These objections, in fact, absolutely condemn all cosmic theories, and oblige us to regard the aurora borealis as a purely terrestrial phenomenon.

OPTICAL THEORIES.

There is a striking analogy and relation existing between the polar aurora and certain clouds, notably the *cirro-stratus*. These relations have been the starting point of another series of theories of the aurora—the *optical* ones. These theories are already found in the germ state in the "Mirror of the King" (*Speculum Regale* or *Konungiega Skuggsia*), a work which was written in Norway at the end of the twelfth century. In this we read the following:

"Some say that it (the polar aurora) is only a reflection of the light of the sun when the latter is below the horizon, while others assert that it is produced by the ice, which radiates during the night the light that it has absorbed during the day."

The latter of these two hypotheses, which consists in seeing in the aurora only solar light reflected toward us by icy particles, was adopted notably by Descartes, Ellis, Frobesius, Hell, etc., and later by Sir John Franklin and F. V. Raspail, and up to 1873 by Mr. Wolfert. It is clear, however, that it comes in contact with important objections. In the very first place, it in no wise explains the undoubted relations of the polar aurora with magnetism and terrestrial currents. Moreover, we know that, in our latitudes, auroræ borealæ are extremely elevated, reaching an estimated altitude of about 200 kilometers. Now, it is very certain that at such an altitude there exists no cloud that could reflect light toward us. As for those auroras near the earth that are observed in high latitudes, even in midwinter, it is none the less evident that their low altitude absolutely prevents them from receiving the rays of the sun.

Another optical theory, indicated vaguely in the "Mirror of the King," attributes the auroral light to a sort of phosphorescence. This enunciation would not suffice of itself alone, inasmuch as it would be necessary to indicate, in the first place, what that body is which possesses so extraordinary a phosphorescence, and then to show how such phosphorescence can explain the relations of the aurora with the magnetized needle. We must, then, reject this optical theory as we did the other. It is possible, nevertheless, that phosphorescence plays a role in polar auroras, not as a cause, but as an effect. There is in the spectrum of the aurora a characteristic yellowish green band, which is the most brilliant of the entire spectrum, and which cannot be referred to any known simple body. Angstroem and Rand Capron are inclined to consider this band as a phenomenon of phosphorescence, or perhaps rather of fluorescence. However this may be, the phenomenon is but an accessory one, and it is elsewhere that we must seek the cause of polar auroras.

MAGNETIC THEORIES.

The magnetic theory of polar auroras is much more satisfactory than the preceding. It explains the majority of the phenomena better, and has still at the present day many partisans, although it seems to us that it must give way before the electrical theories.

These magnetic theories date back to the celebrated Halley, who was the first (1716) to suppose that auroræ borealæ were due to a magnetic, self-luminous vapor. Independ-

THE AURORA BOREALIS AS OBSERVED AT BOSSEKOP IN 1839.

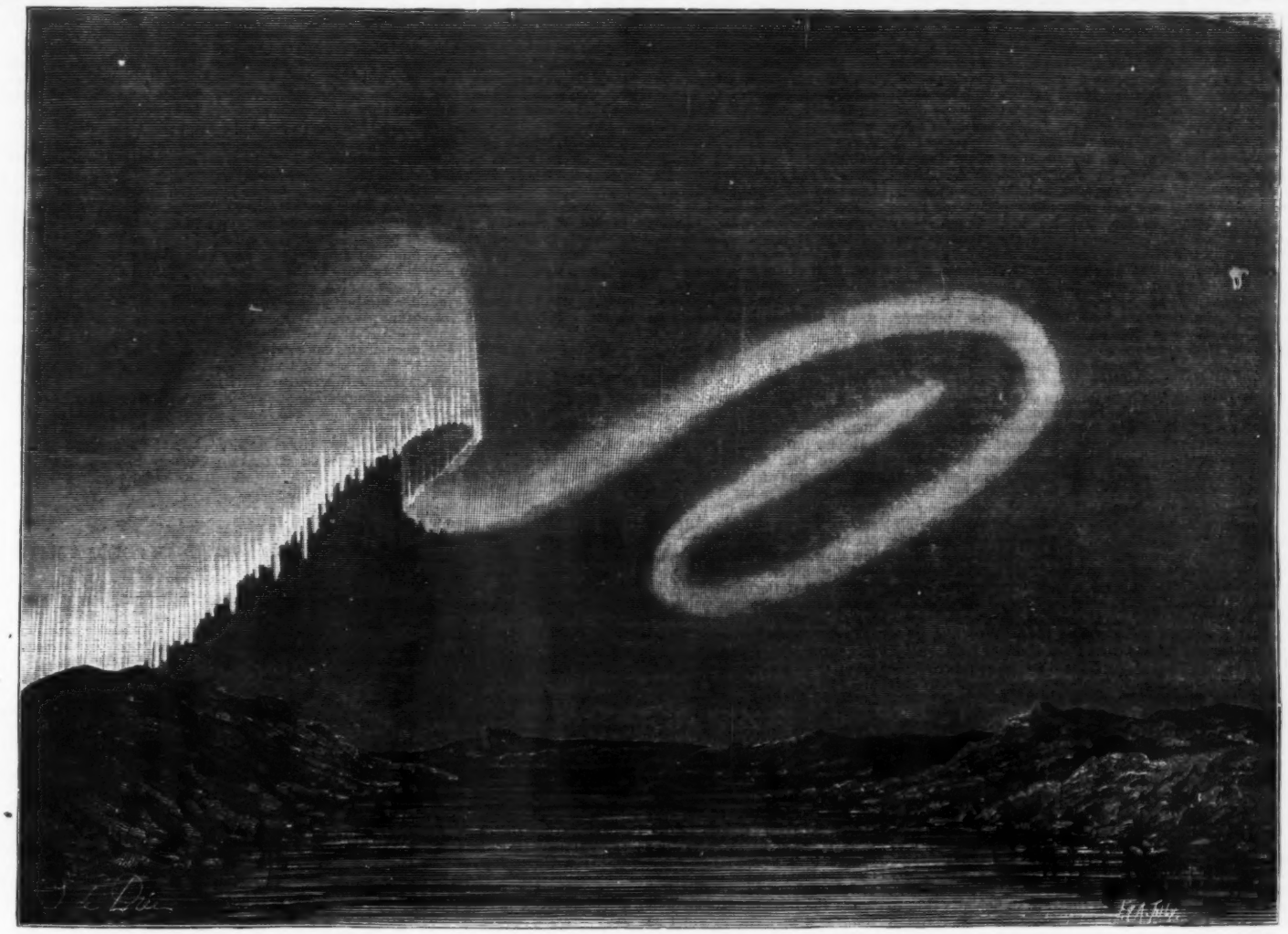
THEORIES AND ILLUSTRATIONS OF THE AURORA BOREALIS.

THE AURORA BOREALIS AS OBSERVED AT BOSSEKOP, IN 1839, IN THE SOUTH.

ently of the vagueness with which it was formulated, this opinion was not adopted, because, at that epoch, electro-magnetism was as yet unknown, and magnetic action had never been seen to produce light.

These theories really assumed consistency only with Dalton (1793). After publishing a large number of observations, Dalton showed once again the relations that existed between these auroras and terrestrial magnetism, discussed the different hypotheses as to the nature of the aurora, and finally agreed that the rays of the latter are composed of ferruginous matters, magnetic of themselves or magnetized under the influence of the earth, which are arranged in position by the earth, the north pole downward, and which serve as conductors for silent electric discharges between the higher strata of the atmosphere and other lower strata. He con-

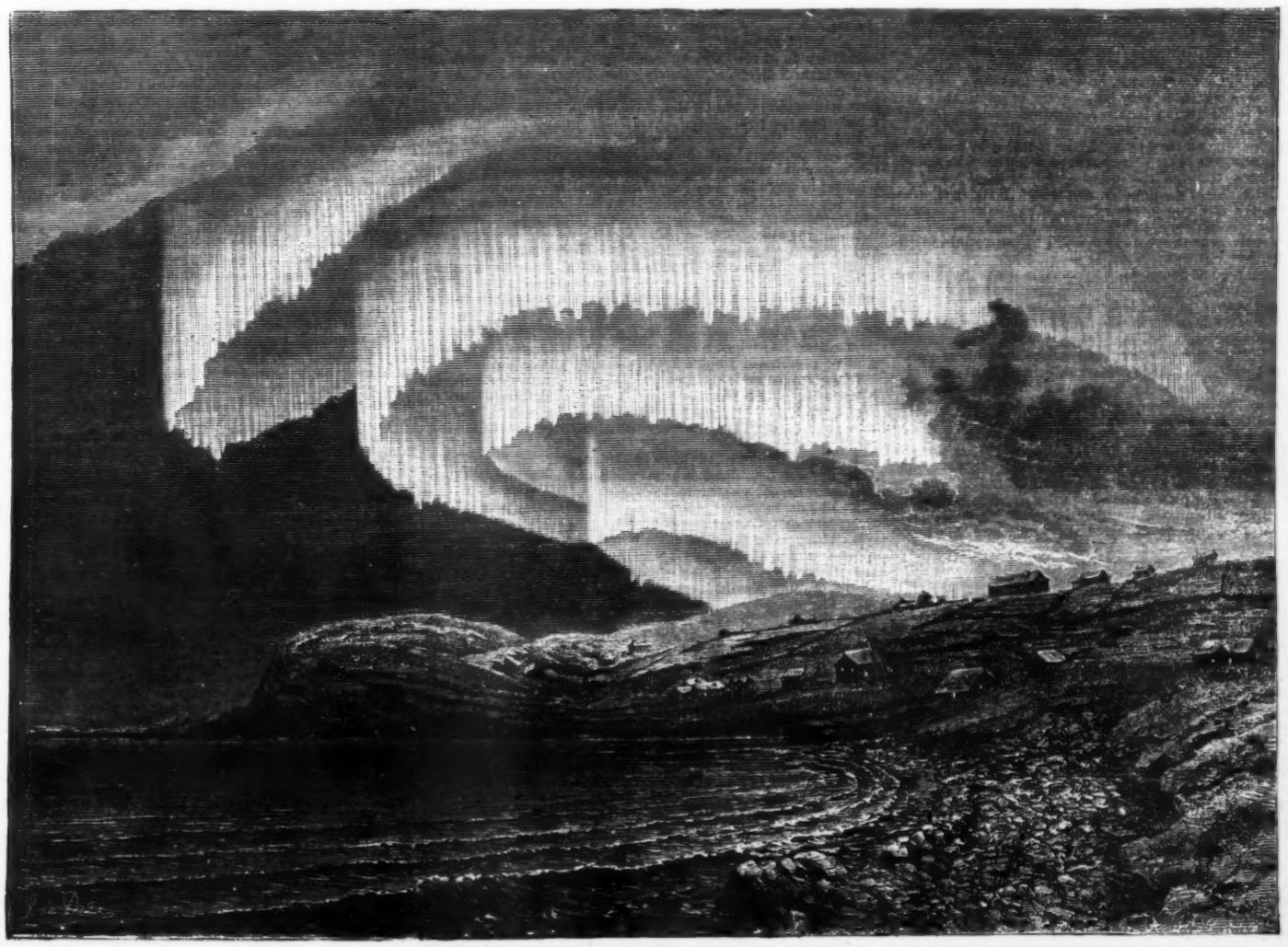
THE AURORA BOREALIS AS OBSERVED AT NOULATO, ALASKA, BY M. WHYMPER.



THE AURORA BOREALIS AS OBSERVED AT BOSSEKOP, DECEMBER 30, 1838, IN THE NORTH-WEST.

lades, finally, that it is not the earth that acts upon the aurora, but the aurora upon the magnetism of the earth's surface.

Dalton's ideas were taken up by Biot (1820), who also explained the production of auroræ borealis by the existence in the air of ferruginous particles proceeding from volcanic eruptions. Mr. Von Baumhauer, of Utrecht (1844), likewise defended Dalton's ideas, but attributed the ferruginous particles, not to volcanic eruptions but to the fall of cosmic dust upon our globe. The light of the aurora would, then, be produced by the incandescence of such dust at the moment it entered the atmosphere, as with meteors and shoot-



THE AURORA BOREALIS AS OBSERVED AT BOSSEKOP, JANUARY 21, 1839, IN THE NORTH-EAST.

ing stars. Among the most recent defenders of this theory more or less modified, we may cite Messrs. Denison Olmsted (1856), Foerster (1870), Zehfoss (1871), Toppler (1872), and, finally, Gronemann (1875).

Among the arguments that may be made to prevail in favor of the magnetic theory, we may cite, in the first place, the very certain authentication of the existence on the earth in the polar regions of large quantities of ferruginous dust, and even of masses of meteoric iron. There has even been observed a falling of dust upon the earth during several auroras, notably at Padua in 1834, and in all of upper Italy at the time of the great aurora on February 4, 1872. Moreover, a spectrum analysis of the auroral light shows that the bands of its spectrum approach pretty nearly some of those of iron. It is clearly, in fine, that this theory helps pretty well, in appearance at least, to explain the relations that exist between the aurora and terrestrial magnetism, and that it might likewise, without much difficulty, be made to explain in quite a plausible manner the different periods that the polar auroras present.

On another hand, these magnetic theories raise numerous objections. In the very first place, the last argument, derived from the analogy of the bands of the aurora's spectrum with those of iron, is far from being decisive. In fact, the bands of the aurora resemble only a few of those of iron, and the most brilliant bands of this metal are absolutely unrepresented in the spectrum of the aurora. So, the majority of spectroscopists do not find it very probable that the spectrum of the aurora is to be attributed to iron, and it seems preferable to refer the former, for the most part, to the spectrum of electric sparks leaping about in very rarefied air. If we wish to attribute an origin which is external to the earth to the ferruginous particles which, according to magnetic theories, constitute auroras, we meet with the objections that we have given above in speaking of the cosmic theory regarding the aurora. Moreover, with this hypothesis of dust derived from interplanetary regions, we should scarcely understand why auroras never occur in the equatorial zone, or especially why their frequency rapidly diminishes from the zone of their maximum as far as toward the poles. If we revert, on the contrary, to the hypothesis of a terrestrial volcanic origin for such dust, neither do we see what should be the cause of the diurnal and annual periods of the aurora, nor especially of the opposition observed in this respect between the regions which are without and within the zone of maximum frequency.

As for the falls of dust which have been observed two or three times in Europe during the occurrence of auroras, we should see therein only a fortuitous coincidence. Never, in fact, up to the present, have analogous falls been described by observers in the polar regions. Now, it is especially in such countries, where the aurora is seen nearly every night, that frequent falls of ferruginous dust ought to be noted were there any relation between them and the production of auroras. Finally, it seems to us very difficult to admit that dust can exert upon the magnetized needle a sufficiently great influence to cause deviations of several degrees, while at the same time forming clouds that are sufficiently thin to permit stars of the fourth magnitude to be seen through them. All these reasons taken together lead us to discard the magnetic theory, as we have already done with the preceding ones.

ELECTRIC THEORIES.

We finally reach the electric theories, which seem to us the ones in which we ought to seek the true explanation of polar auroras. The first person who referred auroræ boreales to a phenomenon purely electrical appears to have been Canton, who, in 1753, remarked the great analogy that auroras exhibit with the electric glow produced in highly rarefied air. In his opinion, boreal auroras are hardly anything else than the form under which storms manifest themselves in the polar regions. These ideas were taken up successively by Priestley, Eberhard, Frisi, Pontoppidan, Benjamin Franklin, etc., without, however, making great progress. It was again a very analogous opinion that was maintained by Fisher, in 1834. According to him, in fact, auroras are a phenomenon due to the positive electricity of the atmosphere; and they occur at the moment in which the electric equilibrium takes place again between the atmosphere and the earth, through the intermedium of particles of ice which are imperfect conductors, and which float in the air and carry the electricity toward the earth. In equatorial regions, on the contrary, in the absence of such particles of ice sufficiently near the earth, the equilibrium could only be re-established by storms.

Dove assigned a more probable origin to many auroræ boreales by supposing that they were produced by the magnetic disturbances of the interior of the earth. For, says he, what is possible to set needles in motion over an extended space can also produce brilliant projections of light when the magnetic disturbance of the earth reaches its highest point. This hypothesis is the more remarkable in that it preceded the discovery, in 1831, by Faraday, of induction currents produced by the displacements or the variations of magnets.

Then came the labors of A. De la Rive, in which, for a short time, it was thought that a complete explanation of the phenomenon had been found. He supposed that auroras were produced by positive electricity, which, in the upper regions of the air, was carried by trade winds from the equator toward the poles; and that upon reaching the polar regions, this electricity accumulated and attracted beneath it negative electricity from the earth. There was thus a sort of condensation, and from time to time, discharges, when the tension of the two electricities reached a certain limit. De la Rive even invented, in 1862, an apparatus which allowed of the reproduction of luminous appearances analogous to those of the aurora. In this apparatus, which is found described in most treatises on physics, the spark from a strong Ruhmkorff coil flashes in highly rarefied air and around a soft iron armature terminating a powerful electromagnet. If we do not dwell longer upon this experiment, it is because it requires conditions that evidently cannot be met with in the atmosphere; and therefore a real explanation of the phenomenon is not to be found therein. We shall say as much of the beautiful simulations of polar auroras that M. Gaston Planté obtained with his powerful secondary battery, when the negative electrode was plunged into a vessel full of salt water, and the positive electrode was caused to approach the moist sides of the same vessel. An experiment having a wider range is that which was performed by Mr. Lemstroem.* A metallic ball, provided with a few points, communicated with one of the poles of a Holtz machine, whose other pole was grounded. At a certain distance from this ball, there were placed Geissler tubes whose posterior extremities were connected with the earth, while the opposite ones (those in face of the ball) were insulated. As soon as the Holtz machine was set in motion, the Geissler tubes were illuminated, although there was a thickness of about two meters of ordinary air between them and the ball, and in which no luminous phenomenon occurred. The slow passage of the electricity, which manifested itself by no light in air at an ordinary pressure, perfectly sufficed, then, to illumine air sufficiently rarefied. Of all the experiments that have been tried up to the present day to reproduce auroras artificially, this is certainly the one that comes nearest the natural phenomenon.

We pass finally to the following theory, which has been published recently by Mr. Edlund,* and in which certain parts of the phenomenon seem to us to have been discussed in a very complete and happy manner.

Mr. Edlund starts from the phenomena called *unipolar induction*, which were discovered by Mr. Weber, and which he himself has studied very completely. It is well known that we designate by this name currents that have their rise in each half of a metallic sleeve enveloping a magnet, when the former is revolved around the latter. The currents are produced in the same manner, whether the magnet remains at rest or whether it be moved in the same direction with the sleeve.

The phenomena of terrestrial magnetism may be explained, as a first approximation, by supposing that the earth contains in its interior a magnet with two poles. The earth being a relatively good conducting body, having a rotary motion, becomes, then, comparable with the sleeve above mentioned, and will thus be traversed by currents due to unipolar induction. For the sake of simplicity, we will first suppose that the axis of the terrestrial magnet coincides with the axis of rotation, that is to say, with the line of the geographical poles. By calculating in this hypothesis all the circumstances of unipolar induction, Mr. Edlund has shown that an electric molecule taken at the surface of the earth is submitted to two forces, the one vertical, from below upward, which tends to drive the molecule into the air, and the other tangential, which, in each hemisphere, tends to draw it to the nearest pole. This second force is null at the equator and at the poles, while the first is maximum at the equator.

Under the influence of these actions, the electricity leaves the earth and accumulates in the atmosphere. The latter takes, then, an excess of electricity with respect to the earth, and this corresponds to the well known fact that the electric potential goes on increasing as we rise into the atmosphere. Now, we know, and Mr. Edlund's researches have much contributed to teach us, that highly rarefied gases conduct electricity very well, the asserted resistance of a vacuum being connected with the difficulty that electricity experiences in passing from the electrode into the surrounding medium, and not in traversing the latter. Once having reached a sufficient height in the atmosphere, the electricity can then without difficulty obey the forces which draw it toward the polar regions. In order to redescend, such electricity possesses two means, these being either disruptive charges through the atmosphere (such as the storms of equatorial regions or mean latitudes), or the slow discharges under the form of continuous currents that occur in high latitudes and give rise to polar auroras.

These continuous currents might occur at the very pole, since, at this point, the vertical force is null; but, in general, the electricity of the atmosphere will re-enter the earth much before reaching the pole, on condition of following the direction of the dipping needle, a direction in which the action of terrestrial magnetism has a null component. In order to flow into the earth, in following such direction, the electricity has to overcome, then, in any latitude whatever, only the resistance of the air. Now, the quantity of electricity thrown into the atmosphere, and consequently its tension, increases with the latitude. There will occur, then, a place where, the tension having become very great, and the resistance of the air being sufficiently weakened, the electricity from the high regions of the atmosphere will flow into the earth in currents in a direction following the dipping needle. As a consequence of the symmetry that we have supposed, such flow will occur according to a zone which will be nearly centered upon the pole.

In reality, the line of the poles of the terrestrial magnet does not coincide with the axis of the earth's rotation; but this does nothing more than complicate the phenomena a little without in anywise changing the general conclusions. Calculation shows that the tangential force is null neither at the geographical pole nor at the magnetic, but at a point situated between the two. The annular zone at which auroras usually occur is no more, then, a circle centered upon the pole of the earth, but a curve which incloses at once the geographical and the magnetic poles, and which intersects the meridian that passes through the magnetic pole at a latitude much higher on the European than on the American side. This is one of the most remarkable concordances with the results that observation has furnished us as to the position of the zone of maximum frequency of the aurora borealis.

If we leave aside the general phenomena of atmospheric electricity, which likewise enter into Mr. Edlund's theory, and if we limit ourselves to what regards the aurora, we find that this theory explains very satisfactorily the following points:

1. The direction of the rays of the aurora.
2. The arc form, and the existence as well as the position of the zone of maximum frequency of auroras.
3. The deviations of the summit of the arc outside of the magnetic meridian.
4. The accidental deviations which may occur if, in consequence of meteorological circumstances, the resistance of the air becomes much less in a certain direction than in that of the dipping needle.
5. The difference in action of different auroras upon the magnetized needle. In fact, so long as the electric current remains constant, it does not agitate the needle, the latter beginning to move only if the intensity of the descending currents varies rapidly.
6. The diurnal and annual variations of the aurora, which may then be connected with the periodic changes that the air's conductivity must experience as a consequence of the variations of the different meteorologic elements.

It seems to us, nevertheless, that this theory, which so remarkably explains most of the phenomena that accompany the auroras of the polar regions, is less satisfactory in that which concerns the auroras of an immense extent that manifest themselves at once in the two hemispheres, upon more than two-thirds of the surface of the globe. We cannot see, in fact, *a priori*, according to this theory, any reason why a so remarkable coincidence should exist between the two hemispheres. It is *apropos* here to say that it seems to us that there are confounded under the common name of polar auroras phenomena that are in reality very different.

In our opinion, the ordinary auroras of the polar regions, those which, for example, were so constantly observed by the French commission at Bossekop, and by Nordenskiold during the voyage of the Vega, constitute a preliminary group of phenomena that are entirely explained by Mr. Edlund's theory. Auroras of this class are in general limited to the polar regions, do not act upon the compass, and only make their presence felt in mean latitudes.

Another class of auroras includes those which, very extended, occur simultaneously in the two hemispheres and are accompanied with great magnetic disturbances in the entire globe. We would consider such auroras as having an entirely different origin from the first, and would connect them with the terrestrial currents that we consider as the cause of these auroras. We have pointed out, in speaking of terrestrial currents, a few of the reasons that support this opinion; and it seems very natural to allow that every sudden rupture in the electric equilibrium of the globe may be accompanied with corresponding electric movements in the conducting strata which form the elevated regions of the atmosphere. As for the first cause of these terrestrial currents, that is as yet absolutely unknown. Must it be connected with the internal modifications of the globe, or rather with certain meteorological conditions of the surface, or, again, with extra-terrestrial or cosmic causes? This is something impossible to decide, so long as regular observations shall not have been pursued during some time on such terrestrial currents.

Finally, we form a third class of phenomena with luminous manifestations that are entirely local, and which seem to be exclusively proper to the polar regions.—*A. Angot, in La Lumiere Electrique.*

PHOTOGRAPHING THE SOLAR CORONA WITHOUT AN ECLIPSE.*

By WILLIAM HUGGINS, D.C.L., LL.D., F.R.S.

My first attempts at photographing the corona were made with photographic lenses; but uncertainty as to the state of correction of their chromatic aberration for this part of the spectrum, as well as some other probable sources of error which I wished to avoid, led me to make use of a reflecting telescope of the Newtonian form. The telescope is by Short, with speculum of 6 in. diameter, and about 3½ ft. focal length. A small photographic camera was fastened on the side of the telescope-tube, and the image of the sun, after reflection by the small plane speculum, was brought to focus on the ground-glass. The absorptive media were placed immediately in front of the sensitive film, as in that position they would produce the least optical disturbance. Before the end of the telescope was fixed a shutter of adjustable rapidity, which reduced the aperture to 2 in. This was connected with the telescope-tube by a short tube of black velvet for the purpose of preventing vibrations from the moving shutter reaching the telescope. On account of the shortness of the exposures, it was not necessary to give motion to the telescope.

It was now necessary to find an absorptive medium which would limit the light received by the plate to the portion of the spectrum from about G to H. There is a violet (pot) glass made, which practically does this. I had a number of pieces of this glass ground and polished on the surfaces. Three or four of these could be used together, castor-oil being placed between the pieces to diminish the reflection of light at their surfaces. Some inconvenience was found from small imperfections within the glass, and it would be desirable, in any future experiments, to have a larger supply of this glass, from which more perfect pieces might be selected.

In my later experiments I used a strong and newly-made solution of potassic permanganate, in a glass cell with carefully polished sides. This may be considered as restricting the light to the desired range of wave-length, since light transmitted by this substance, in the less refrangible parts of the spectrum, does not affect the photographic plates.

Different times of exposure were given, from so short an exposure that the sun itself was rightly exposed, to much more prolonged exposures, in which not only the sun itself was photographically reversed, but also the part of the plates extending for a little distance from the sun's limb.

Gelatine plates were used, which were backed with a solution of asphaltum in benzole.

After some trials I satisfied myself that an appearance peculiarly coronal in its outline and character was to be seen in all the plates. I was, however, very desirous of trying some modifications of the method described, with the hope of obtaining a photographic image of the corona of greater distinctness, in consequence of being in more marked contrast with the atmospheric illumination.

Our climate is very unpropitious for such observations, as very few intervals, even of short duration, occur in which the atmospheric glare immediately about the sun is not very great. Under these circumstances I think it is advisable to describe the results I have obtained without further delay.

The investigation was commenced at the end of May of this year, and the photographs were obtained between June and September 28.

The plates taken with very short exposures show the inner corona only, but its outline can be distinctly traced when the plates are examined under suitable illumination. When the exposure was increased, the inner corona was lost in the outer corona, which shows the distinctly curved rays and rifts peculiar to it.

In the plates which were exposed for a longer time not only the sun, but the corona also, is photographically reversed, and in these plates, having the appearance of a positive, the white reversed portion of the corona is more readily distinguished and followed in its irregularly sinuous outline than is the case in those plates where the sun only is reversed, and the corona appears, as in a negative, dark.

I have Captain Abney's permission to add the following letter received from him December 15, 1882: "A careful examination of your series of sun-photographs, taken with absorbing media, convinces me that your claim to having secured photographs of the corona with an uneclipsed sun is fully established. A comparison of your photographs with those obtained during the eclipse which took place in May last, shows not only that the general features are the same, but also that details, such as rifts and streamers, have the same position and form. If in your case the coronal appearances be due to instrumental causes, I take it that the eclipse photographs are equally untrustworthy, and that my lens and your reflector have the same optical defects. I think that evidence by means of photography of the existence of a corona at all is as clearly shown in the one case as in the other."

---

* *Archives des Sciences Physiques et Naturelles*, 1875, tome 54.

* Recherches sur l'induction unipolaire, l'electricité atmospherique et l'aurore boréale, par E. Edlund. Stockholm, 1878.

*Abstract of a paper read before the Royal Society, Dec. 13, 1882.

APPARATUS FOR REGULATING PRESSURE IN WATER CONDUITS.

THE apparatus shown in the annexed Figs. 1 and 2 has been devised by Mr. Eichenauer (German patent No. 18,666) to deaden the shocks that occur in water conduits and to remove the air from the latter.

The apparatus, A, is placed at the side of the conduit, B, into the circuit of which it is introduced by opening the slides or valves, C_1 and C_2, and by closing C. This arrangement renders the apparatus accessible for repairs without its being necessary to shut off the water in the conduit. If it is a question, for instance, of filling the empty conduit, D, with water, without the necessity of being obliged to open cocks or other apparatus in order to give exit to the air, the apparatus will operate as follows: The air, forced in the direction of the arrow through the channel, *g*, will be compressed in the cap, *h*, whence it may disengage itself through the valve, *e*, until the water, which has in the mean time entered the cross shaped piece, *r*, lifts the floating piston, *a*, and thus closes the valve, *c*, that rests on the rod which guides it. Inversely, when a portion of the water conduit is emptied, the piston, *a*, falls with the water which is flowing out, and opens the valve, *c*, thus allowing a re-entrance of the air.

The air which has accumulated in the conduit during its operation disengages itself in the same way automatically. As this air always flows to the highest points, it will collect in the cap, *h*, over the piston and finally depress the latter and open the valve, *c*, when its pressure has become greater than that of the water. There will thus be a constant equilibrium between these two pressures, and, besides, the air will prevent the water from rising too high in the pipe, *g*.

The injurious influence of the shocks that occur in the conduit is prevented as follows: If, for example, the shock acts from the left, it will compress the spring, *k*, by means of the piston, *e*, and, this spring being exactly regulated for a normal pressure, the piston, *e*, will in a certain measure close the aperture, *l*, in the tube, *d*, serving as a guide to the said piston. At the same time, the rod, *o*, will be raised by the rod, *m*, of the piston and by the bent lever, *n*, in such a way that the piston, *g*, will be forced by the two armed lever, *p*, to close the aperture, g_1. The shock is thus confined in the pipe, *g*, and in the cap, *h*, while the cross shaped piece, *r*, and the part, D_1, of the pipe is closed. This difference in pressure causes the piston, *a*, to fall, so that the injurious effect of the shock is suppressed by the opening of the valve, *c*. When the shock has thus been balanced, the spring, *k*, carries the piston back to its normal position. The same thing occurs when the shock is produced from the other side.

The apparatus shown in the cut is designed for a conduit of 0·15 meter internal diameter with a pressure of four atmospheres. It is wholly mounted upon the cross shaped piece, *r*, which is provided with two manholes, *s*, in order to allow of easy access to the attachments of the piston rods.

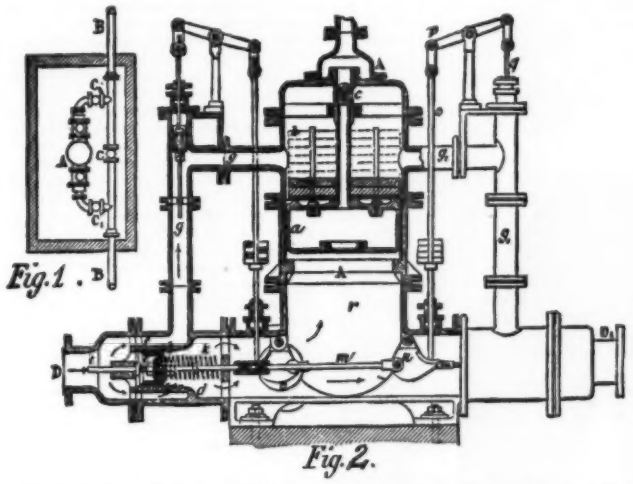


Fig. 1.

Fig. 2.

APPARATUS FOR REGULATING PRESSURE IN WATER CONDUITS.

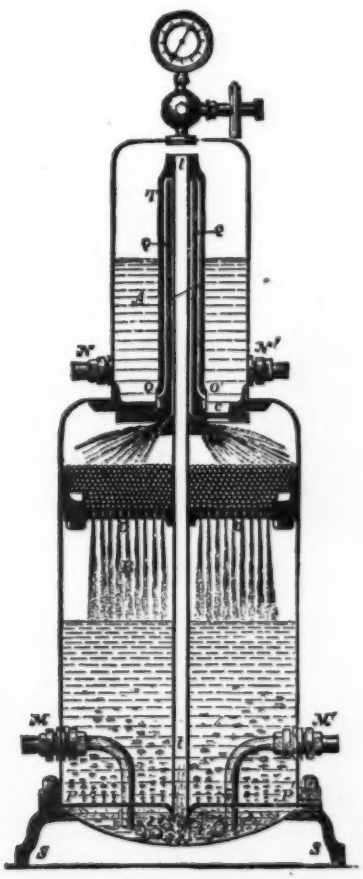
During its normal operation, the water passes from D, through *t*, into the annular opening, *f*, and enters the tube, *d*, through the slit, *l*, then enters the piece, *r*, and finally the part, D_1, of the conduit.—*Dingler's Polytechnisches Journal.*

THE "CASCADE" SATURATOR.

WE here illustrate an invention by M. Mondollot. This is a new saturating cylinder for saturating water with carbonic acid gas without the usual agitators, and which, from its method of action, has been named the "Cascade." So far back as 1821 the system of aerating or carbonating water in a cylinder without an agitator was known, but not until recently has the internal arrangement been rendered sufficiently effective for this method to be successful in actual practice. The chief point to be aimed at in perfect saturation is the minute subdivision of the water, so as to insure a thorough incorporation of the carbonic acid gas. This result has been almost universally obtained by the introduction of revolving fans that beat up the gas and water. The objection to this plan is that more or less friction is unavoidable, and consequently there is a risk of metallic contamination of the water, and of leakage at the stuffing box of the fans. These difficulties are entirely avoided by M. Mondollot's new system of agitation, which gives perfect aeration to the water. In our engravings Fig. 1 represents an exterior view of the "Cascade" saturator, Fig. 2 being a vertical section. Although forming one vessel, this saturator is divided horizontally into two chambers by the plate, C. These chambers are placed one above the other, the upper and smaller one, A, being the distributer, and the lower and larger one, B, the accumulator. The action of the pumps drives the gas and water through the opening, N N, into the distributer, and there, by the respective difference of their weights, the gas and water separate, as they would do in a bottle. As the pumps continue their work and increase the pressure in the distributer, the gas and water seek to find their way into the accumulator. The water passing up the tubes, O O, and down again, is conveyed to the upper part of the accumulator, where it is projected through the holes, *i i*, on to a close layer of marbles, through which it dribbles slowly and falls in a fine spray through the perforated disk, D, on to the water below. During the whole of this process it will be noticed that the water passes through the carbonic acid gas, which is under a high pressure, and so it absorbs, by contact, a maximum of this gas. The carbonic acid gas, on the other hand, is taken by the central tube, T T, to the bottom of the accumulator, where it rises up in small bubbles through the perforated plate, P P, and then through the water. The water, thoroughly saturated, is then carried on to the bottling stands by the tubes, M M. As the pressure diminishes in the lower cylinder through the water being drawn off to the bottling stand, and the pressure in the upper one increases through the action of the pumps, the water and gas are constantly traveling, as described, to restore an even pressure in both cylinders. The point of importance is that the gas and water are first pumped together into the upper chamber and then are thoroughly mixed and incorporated by the water falling in a cascade through the carbonic acid gas under pressure, and the gas bubbling up through the water under pressure. This gives the largest surface exposure attainable.

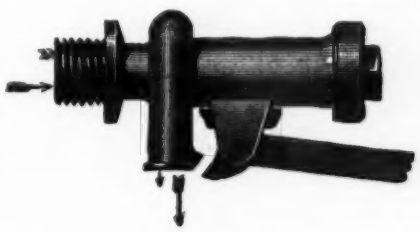
The practical advantages of this saturator are that the risks of metallic contamination, and of leakage, are entirely avoided, and every particle of water being brought in contact with the carbonic acid gas under pressure, it is more perfectly saturated, and can be bottled at a pressure of from 70 lb. to 80 lb. with excellent results. Then again it is found that the water, when drawn off into bottles or siphons, is not nearly so wild as when it has just been churned up by a fan, does not fly out of the bottle, and will retain the gas longer. Moreover, as the water is saturated on its passage into the lower chamber, it is ready to be drawn off immediately without remaining in the cylinder, and on these grounds the "Cascade" saturator commends itself favorably to notice.—*Iron.*

FIG. 1. THE CASCADE SATURATOR. FIG. 2.

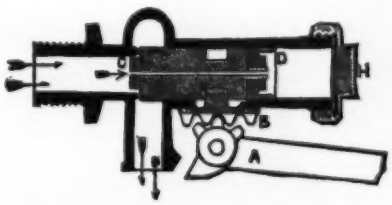


IMPROVED BALL VALVE.

THE ball valve illustrated herewith is very simple and at the same time perfectly efficient. A small hole is made through the valve, so that when closed the pressure of water within the valve acts in such a way as to close it the more



effectually the greater the pressure. Water passes through the valve at C, and acts on the cup leather, D, and at the same time the buoyancy of the ball causes the lever at A, which is furnished with a pinion, to act upon the rack, B, and close the plunger upon its seating. The area of the cup leather, D, being larger than the face of the plunger at C, the valve is by the water pressure tightly closed, its security



not depending upon the buoyancy and leverage of the ball alone, but being supplemented and its action controlled by the action of the ball. A clear way is given for the water, and the valve cannot apparently get out of order.

PROTECTING IRON AND STEEL FROM OXIDATION OR RUST.

FIRST Barff and then Bower devised a process for covering wrought and cast iron and steel with a thin film of the magnetic or protosesquioxide of iron, which has the property of protecting the underlying metals from the action of air and water. These two inventors subsequently united their efforts, and the result of their investigations was a practical process of great industrial importance. Two methods of equal simplicity are employed, according as the article to be protected is of cast or of wrought iron.

The first process, which is excellent for cast iron, consists in heating the article to be protected to a bright red heat in a closed and arched chamber, and then passing over it a mixture of carbonic acid and air. This oxidizes the iron and forms a very thin layer of sesquioxide on the surface. In order to convert this into the magnetic oxide, it is only necessary to bring it into contact with reducing gases like the hydrocarbons or carbonic oxide, both of which are able to rob the sesquioxide of a portion of its oxygen. The process, then, consists of two parts—an oxidation, producing the sesquioxide, and a deoxidation, converting the sesquioxide into magnetic oxide. This alternate oxidation and reduction is accomplished mechanically by a properly timed opening and closing of the valves that admit the air or connect with the retorts.

The heating chambers are made of refractory bricks, and consist of a hearth with an arched vault, the ends being closed with doors lined with the same kind of brick. During the first part of the operation, the hydrocarbons, which are always mixed with a little carbonic oxide, are burned before they enter the working chamber, which is thus filled with carbonic acid and air in excess, so that sesquioxide of iron is produced. During the second period the air valve is closed, the gases are no longer burned, and the hydrocarbons fill the heated chamber, converting the sesquioxide into magnetic oxide.

The article must not be placed directly on the floor of the chamber, and is therefore best placed on a little truck on which it is run in and out of the chamber. A furnace having a capacity of three cubic meters (106 cubic feet) will hold a charge of 880 to 8 300 lb, according to the kind of articles treated, and the operation lasts from three to six hours, so that 2½ to 5 tons of iron can be run through in twenty-four hours with the consumption of 1,100 to 1,300 lb of fat coal. The furnaces are 20 feet long.

The second method is applicable to wrought iron and steel. It consists in heating the articles to a dark cherry red in a closed chamber and then letting in steam superheated to 700° C. (1,292° Fahr). The steam is decomposed by the red hot iron, the hydrogen is liberated, and the nascent hydrogen attacks the metal, converting the surface into the magnetic oxide, the thickness of which depends on the duration of the action, which is usually from three to seven hours.

The articles are put on iron trucks and run into cast or wrought iron retorts with doors at both ends. A steam pipe introduces the superheated steam into the upper part of the retort. The steam is generated in a portable generator placed near the furnace. The quantity of steam used in one operation is very small; the amount of water to be evaporated to fill a retort having a capacity of 133½ cubic feet is only eight or nine gallons per hour. The weight of the charge will vary from 880 lb. to 3,960 lb. making 5,280 lb. to 11,880 lb, of oxidized material in twenty four hours. The consumption of fat coal is about 1,760 to 1,980 lb.

These processes can be employed in all cases where it has hitherto been customary, in order to prevent their rusting, to apply some greasy substance or varnish, or a coating of another metal, galvanizing, enameling, tinning, etc.

The organ of the "Societe d'Inoxydation" has conducted different experiments to test the efficiency and durability of their process. Among other things, they put some articles in a privy vault and exposed others in storms and bad weather, some of each being protected by the coating of oxide while the rest were not. In every case the former retained their original condition, while the latter were deeply rusted.

These processes have still another advantage, namely, that while the removal of this coating film, either accidentally or intentionally, on any spot permits of its rusting there, the rust is confined to the denuded spot and does not extend any further, as it does in galvanized vessels.

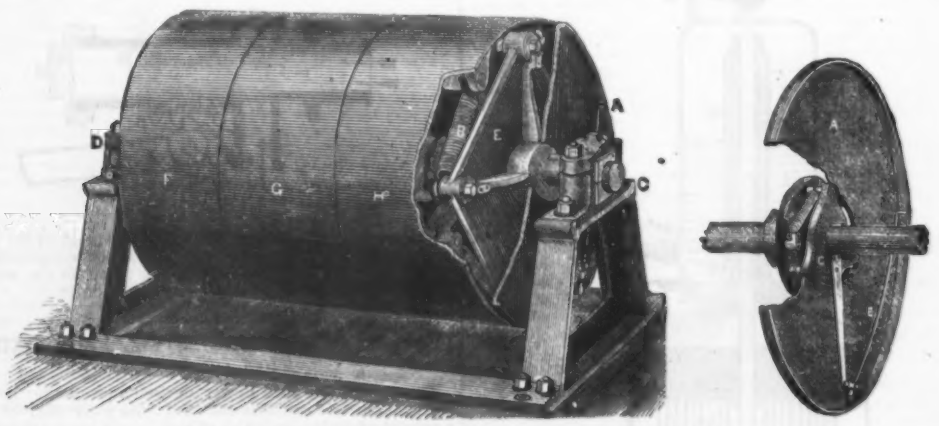
A further advantage of this process by oxidation consists in the fact that the weight is very slightly increased, which is of importance in some cases, as for instance in sheet iron used for roofing. As the thickness of the oxide coating is practically nothing, all the details are preserved on ornamental castings in their original sharpness, which is not the case with enameled ware. The protected spots can be silvered with excellent effect. For artistic castings like statues, etc., the artist can obtain entirely new and remarkable effects by its aid.

It only remains for us to state that the cost of oxidation is small, so that its use should become very general The price per hundred kilos is four to eight francs (or 36 to 72 cents per 100 lb.) according to the kind, size, and weight of the things to be treated, whereas the cost of galvanizing is 250 to 300 francs per hundred kilos(?), or more than thirty times as much.—*Berg und Hütten, Zeitung.*

IMPROVED DYNAMOMETER.

THE accompanying engraving of this dynamometer, the invention of Messrs. Ayrton & Perry, shows it as worked out practically and made by Mr. A. R. Sennett, Hatton Garden London. It is for the purpose of measuring the power transmitted by belting from one machine to another. F is a pulley rigidly fixed to the shaft, C D, turning in two plummer blocks carried by A frames resting on the floor or by brackets fastened to the wall; *g* is a loose pulley, and H is a pulley loose on the shaft, but joined by the spiral springs, B, to a ribbed plate, E, which is rigidly fixed to the shaft, C D. The engine belt is put on F, and the belt to the dynamo-electric or other driven machine on H, or *vice versa;* hence the pull to drive the machine is transmitted through the spiral springs, which are consequently stretched, and the amount of stretch measuring the twisting force transmitted. To measure this stretching the following device is employed: An arm fixed to the plate, E, on a small link motion, seen at the right hand lower corner of the figure, and which causes a bright bead, A, at the end of the left arm to approach toward the center. Consequently the radial motion of the bead, A, records on a magnified scale the extension of the spiral springs. As the bead revolves a bright circle of light is seen, the radius of which diminishes as the pull on the springs is increased. Hence the horse power being transmitted at any moment is at once known by observing on a fixed graduated scale, supplied with the instrument, the radius of the circle of light described by the bright revolving bead and the speed of rotation.

To obtain great delicacy for powers varying within certain limits from that normally transmitted, the arm carrying the bead is made slightly flexible, so that when no power is being transmitted, the bead is pressed with a certain force against the rim of the front plate; hence the plate does not commence moving until a certain prearranged horse power at a given speed is being transmitted, and its whole radial motion therefore is completed for a certain additional transmitted horse power, the necessary addition depending on the power of the springs and the leverage of the circle motion. Consequently, a large change in the radius of the circle of light is produced by a small change in the transmitted horse power.—*The Engineer.*



AYRTON AND PERRY'S DYNAMOMETER.

THE CURSOMETER.

A CORRESPONDENT of *La Nature* sends to that journal the following description, accompanied by an illustration (reproduced in the accompanying cut), of an apparatus designed to measure the speed of railway trains while under way.

THE CURSOMETER.

The apparatus shown in the cut is one that has been graduated especially for mixed trains. As will be seen, it is simply an hour glass, in which one of the bulbs is replaced by a calibered tube, at one side of which are marked the seconds, and at the other the speeds in kilometers reduced to hours.

Its operation is as follows: Before using the apparatus, it is held vertically, the larger bulb downward. Just as a kilometer post is being passed, the apparatus is suddenly inverted, and, when the next post is reached, it is slightly inclined at the precise moment that the post passes before one's eyes. It is only necessary then to read the graduation to have the speed in kilometers. By means of the ribbon affixed beneath, the instrument may be attached to one of the observer's coat buttons.

"This is, I believe," says the inventor, "the cheapest chronograph that has ever been made; for the instruments cost me no more than 75 centimes each. The concordance with the 60, 90, and 120 franc tachymeters with which I have compared it falls within a quarter of a second, more or less. The instrument figured herewith was graduated on a locomotive under way in order to take into account how much settling may occur in the sand. The other instruments that I have constructed for the use of the machinist are less fragile, are set into wood, and have the form of a thermometer."

INCOMBUSTIBLE WRITING AND PRINTING PAPER.—Asbestos of the best quality is treated with potassium permanganate, and then with sulphuric acid. 95 of cent. of such asbestos is mixed with 5 per cent. of wood pulp in water containing borax and glue. A fireproof ink is made of platinous chloride and oil of lavender, mixed, for writing with India ink and gum, and for printing with lampblack and varnish.

SUPERHEATED STEAM.

To the Editor of the Scientific American:

The object of this communication is to present the true nature and properties of superheated steam, and also to demonstrate its relative economy and safety in use, over that of saturated steam.

With the public at large, there exists a profound misunderstanding upon this important subject; affecting vast industrial interests, as well as the action of underwriters in disposition of fire risks.

It is generally supposed that superheated steam involves giant explosive forces, and that its use is attended with imminent danger to life and property. That the converse of this proposition is true will be received by many minds with much incredulity, but doubt and skepticism must give way before the irresistible advance of truth and fact.

The true proposition is that superheating steam is the safest and most economical method of using this great motive power (steam), as we will now propose to demonstrate, beginning with its economical feature.

Its value has been demonstrated by the most distinguished engineers, from Watt down to the present day, as the best means of preventing "cylinder condensation," to which has been attributed the true cause for the enormous loss sustained in the use of the steam engine by the present method of using saturated steam. The manner in which this loss occurs is exemplified as follows: With a cylinder in which steam at half stroke, or 50 per cent. cut off, is used—say at any pressure—imagine the steam admitted until the piston reaches half stroke, the boiler communication closed, and the steam allowed to expand through the rest of the stroke, the exhaust opened, and the piston returned; then upon the steam coming in on the next stroke, we would naturally expect to find the internal surfaces in the same condition as they were at first.

But experiments and all experience have proved that in the operations which have gone on during the first stroke, the internal surfaces have become chilled to a certain extent, and that a considerable portion of the steam entering is condensed by them and converted into water.

This fact has been shown by Isherwood in his experiments, made with great care and expense, and subsequently demonstrated by Mr. Doxwale, in presence of a board of U. S. naval engineers consisting of Charles H. Loring, Charles H. Baker, Edward Farmer, and indorsed by Wm. H. Shock, Engineer in Chief of the U. S. Navy, and chief of the Bureau of Steam Engineering, Washington, March 24, 1877. The result has been found to be nearly thirty-nine per cent. loss, at half cut off; and the best engineers now estimate that about one-third of the fuel is thus made inoperative and wasted.

The only known remedy for the prevention of "cylinder condensation" is the proper use of superheated steam, by which one third of the 85 millions of tons of coal now annually used in industrial pursuits would be saved, representing in money nearly $100,000 000 per annum.

The primary causes of cylinder condensation are external and internal radiation of the metallic surface, conversion of heat units into work, and conversion of heat into work done during the first rush of the steam from the cylinder after the opening of the exhaust. A further economic effect is produced by the great increase of volume of steam caused by the addition of superheat. If 400 deg. is required in the cylinder (which it is perfectly safe to use) at one half cut off, it would be necessary to have the steam in the superheater at about 596 deg, so that having it expanded down to 400 deg. at the half cut off, you not only suppress entirely cylinder condensation—with its enormous saving—but you increase your power about one sixth.

In relation to the question of safety, let us give an example of the manner in which superheated steam acts in the cylinder. First, it follows a different law from saturated steam; it is governed by Mariotte's law of gases and air. You can by the addition of 480 deg. of heat to the steam in a separate vessel, or superheated, double its volume, and also its pressure: if it were attempted to raise steam in a boiler to 692 deg., it would have to be strong enough to resist a pressure of 2,500 lb. to the square inch.

One pound of water heated in a boiler to 212 deg. is by the addition of 966 units of heat converted into 1,720 volumes of steam at atmosphere pressure. The 1 720 volumes may be taken as the measure of the available mechanical force—the 966 units of heat being worth 1,720 volumes of steam. Now, if these 1,720 volumes of steam at 212 deg. be raised 480 deg. higher, or to 692 deg., you will have 3,440 volumes of steam at *double the pressure*, or 15 lb. to the square inch. The 480 deg. used upon the steam has given you the same quantity as 966 units used upon the water.

How much heat is required to raise 1 lb. of steam 480 deg.? The specific heat of water is 1·000; the specific heat of steam is 0·475, or a unit of heat will raise 1 lb of water 1 deg., and 1 lb. of steam 2 deg. But in our case, suppose the steam was raised 480 deg; and now it is evident that, at a cost of 240 units of heat, the 240 units of heat used in superheating have done the work of 966 units used upon water; heat goes *four times further* on steam than it does on water, and if the heat costs the same as when used upon water, the clear gain is 25 per cent.

The *modus operandi* of superheated steam in the cylinder is this: All superheat is given off *before condensation commences;* the moment the superheated steam enters the cylinder, the superheat is absorbed by the metallic surfaces. The piston is now propelled, with steam less the superheat, to the point of cut off. When a portion of the steam is converted into work, and the balance expanded into the remaining half of the cylinder, now the superheat absorbed by the metallic surfaces (upon the principle that all things in nature seek their equilibrium) gives out its superheat to the devitalized steam—revivifies it to a condition to enable it to perform the other half stroke; and the exhaust is then discharged at saturation.

Steam used in this way makes the modern steam engine the most perfect in the world; it enables the maker to exhibit it as a real steam engine, and not one working half water.

Steam power is a vital necessity of the age, and buildings are covered by insurance, in which this great economizer of time and labor is in continual use, without being considered extra hazardous.

Now, if A uses 60 lb. pressure in his boilers, 300° Fahrenheit is all the heat he can obtain at that pressure. Should he require 650° to boil oil, so as to perform the work without danger of explosion from the escaping inflammable vapors, he could not obtain it in his present boilers. He would have to obtain one capable of sustaining a pressure of at least 5,000 lb. to square inch to conform to regulations, which require double resisting power to the pressure employed; the boilers would have to be made from three to four thicknesses of metal in proportion to diameter.

An apparatus of this kind would be a live volcano. No employe would stoke the fires, nor any sensible engineer attempt to superintend its operation. It is just here where the important use and great value of superheated steam comes in to the assistance of all industrial and scientific enterprises. It is well known that superheated steam follows an entirely different law from ordinary steam. One cubic inch of water makes 1 cubic foot of steam at 212°, or atmospheric pressure resisting 14½ lb. to square inch. A pound of saturated steam contains 966 units of latent heat, or heat not shown by the thermometer, and 212° of sensible heat, making together 1,178 units of heat, the emblem of steam at saturation.

In a boiler, as soon as 212° is reached with the safety valve open, increase of heat produces an increased evaporation of water into steam, but of no greater temperature. Close the valve, and the heat increases with its pressure in regularly observed ratio. But with superheated steam it is entirely different. Take the steam from off the water in a boiler and allow it to pass through a superheater, and you can only double its pressure by an additional 480° of heat, which added to 212° would give 692° with only 29 lb. pressure.

Therefore, for industrial purposes, you save by its use four-fifths of fuel, because if 1,000 volumes cost 50 lb. of coal to vaporize, you can obtain 3,000 volumes by superheating it, which can be done at an expenditure of only 10 lb. of coal, or one-fifth.

There is certainly less danger in using steam at 30 or 40 lb. pressure than in forcing boilers to 90 to 100. I have seen in large factories steam used at 125 lb. pressure where a high heat, say 350°, was required continually.

The danger from superheated steam (heat without extra pressure, *i. e.*, when there is no check valve between the boiler and superheater) is not increased. All well regulated factories have their steam pipes properly covered. Patented air space, asbestos, and fossil meal non-conductors are now in practical use, and as this supposed danger is incurred only at the palpable expense and inconvenience of the consumer, he will see to it that his steam and hot air pipes are well protected by non-conductors. Otherwise he could receive no advantage or benefit for his outlay for superheating steam or hot air apparatus. When we take into consideration the vast and constantly increasing field of industrial pursuits in which superheated steam of high temperatures is an absolute necessity; that its use cannot be superseded by any substitute, either for economy, practicability, or safety; that upon its use depends the safe distillation and refinement of oils and other hydrocarbons, as well as the manufacture of soap, heating cities by underground conveyances, etc., industries involving millions of money, and the support of thousands upon thousands of laborers and their dependent families, we will naturally view with serious concern any and all endeavors to interfere with the legitimate use of so important a factor in the engineering world. It would seem to the educated mind that the progress of improvement in the adaptation of steam to industrial purposes should not be checked or interfered with through the ignorance and prejudice of non-professional and unskilled presidents and directors of insurance companies.

Every company of fire insurance should employ a skillful engineer and scientist to examine all applications for insurance where steam is used, whose favorable report should be accepted as a full waiver of objections to the underwriters.

If this were the case, those engaged in the building of superheating steam apparatus and the users thereof would cease to complain of the present unjust exactions of most insurance companies.

As it is, many insurance offices demand an extra premium on the entire risk, rendering it impossible for the manufacturer to avail himself of modern improvements, and subjecting the inventor and patentee to irreparable loss.

If, on the other hand, a full knowledge of the subject was entertained by the aforesaid presidents and directors, the rule in all justice would be reversed, and a less premium demanded where the superheater was in use, as the risk is materially lessened. In presenting our case, we have used only well established facts, and relying solely upon these we confidently anticipate a change of policy on the part of those who at present act not only against the vast manufacturing interests of the country but also against their own.

S. N. CARROL.

New York, Jan. 11, 1883.

AERIAL NAVIGATION.

By F. BARNETT.

Utility.—To be of any great utility, it must be superior to terrestrial navigation. It must either transport greater weights at an equal speed or equal weights with a greater speed, or where one factor is less, the other must be correspondingly greater to make a product that is superior to all other kinds of navigation.

Perhaps the greatest utility would be in speed. A great deal of the heavy commerce as carried on to-day is done in a reasonably short time; but the speed with which the lighter traffic is carried, such as people, mail, and express matter, could be very profitably increased.

But suppose we find a capability in aerial navigation of carrying great weights with greater facility and speed than is now known, it also would be of great benefit to humanity. The natural products of different climes could be exchanged with much less labor and expense.

The simple balloon is unreliable. The balloon with propellers is necessarily so large as to offer such a resistance to the air as to retard its velocity very much. It cannot acquire any great momentum, and momentum is a storage of power. But even if such a balloon with propellers did acquire a velocity of ten miles an hour, it would be of little use except to the pleasure seeker.

The ideal air-ship would have a speed of from sixty to a hundred miles an hour, and carry quite a number of passengers and freight. Its course must be certain and its voyages always end safely. Therefore, in constructing an ideal machine, we must consider its *weight*, *velocity*, *momentum*, and *form*.

Weight.—Weight is absolutely necessary to horizontal flight, and not only so, but contributes to it. Without weight, no momentum could be acquired, and momentum is an accumulation or storage of power or energy. Weight is easily moved in a horizontal direction by a slight but constant force, but not easily or suddenly changed about by the wind like a lighter body.

If the resistance to horizontal motion be one pound per second and the momentum ten pounds per second, then, if the live force be suspended, it will take ten seconds before the power of momentum is used up. But in a balloon, the resistance is equal or perhaps exceeds the momentum, and the horizontal motion depends entirely upon the live force. This power of momentum can be changed to an upward force or power. A momentum of ten pounds would lift the body one foot high in one second.

Momentum is a storage of energy. A bird in flapping its wings expends a certain amount of energy in the down stroke. Then to make the up stroke, it must not only counteract the momentum of the wing acquired in the down stroke, but use the same amount of energy to make the up stroke as it did the down stroke. The momentum acquired in the down stroke is not only lost, but must be neutralized by the same amount of energy. The momentum acquired by one revolution of a screw propeller is not counteracted, but helps the original force.

Velocity.—Is one of the factors of momentum.

If the propelling power, which we will assume is constant and acts in a horizontal direction, is any in excess of the resistance, then, no matter how slow the initial velocity, the body will ultimately acquire an accelerated velocity which would be very considerable, or so great that the resistance of the air alone would be equal, and then the body would assume a uniform velocity. It is from this very reason that the balloon cannot be propelled with any great speed. The resistance, which increases as the square of the velocity, too soon becomes equal to the propelling power.

Thus: If the propelling power be 90, and the resistance at the rate of one foot per second be 10, then the resistance at three feet per second would be equal to the power.

Momentum.—Is a storage of power.

If the resistance to horizontal motion be one pound per second, and the momentum ten pounds per second, then it will take ten seconds before the power of momentum is exhausted. A body in falling stores up enough power to carry it to the same height, less friction; or to lift ten times its weight one-tenth as high. This power is in the momentum, and does not depend upon an outside force. No force is ever lost; it is simply converted into different forms or results. The force of momentum, if utilized, can be changed to a lifting force. That is, the direction of the force of momentum is changed.

The advantages of momentum in horizontal motion would be great. If the propelling power were suddenly stopped, it would carry the machine quite a distance, or at its then acquired speed less the friction of the air. All excess of propelling power over the resistance of the air would result in an accelerated velocity, or an accumulation of power or energy; while a body that has no weight can acquire no momentum and consequently no acceleration of velocity.

The Advantages of Momentum in Screw Propellers over Wings.—The momentum acquired in the down stroke is not only lost, but must be neutralized, before the up stroke can be made, by the same amount of force in the opposite direction. In addition to this, the same amount of force must be used to make the up stroke as was used to make the down stroke. There was sufficient momentum acquired in the down stroke to make the up stroke, if it could have been properly utilized.

SINKING OF THE ORIENT S. S. AUSTRAL IN SYDNEY HARBOR.

THE SINKING OF THE AUSTRAL.

THE history of maritime disaster records no occurrence more extraordinary than that which has led to the sinking of one of the largest and finest steamships in the world in the waters of Port Jackson. It appears that while lying snugly at anchor in Neutral Bay, receiving coal from a tender alongside, the Orient steamer Austral suddenly listed over, and her ports being open, the water poured in so rapidly that she foundered in a few minutes. There were on board at the time the officers and crew, numbering between seventy and eighty men, and of these five are known to have perished; the others just succeeded in saving themselves by jumping into the lighter alongside of the ship. The majority of them were in their berths sound asleep at the time the alarm was raised, and had only time to rush out half naked as they were and escape. Of course, as might be justly imagined, a great uproar and confusion arose on board among the terrified crew, and their shrieks and cries for assistance were, fortunately, by no means without avail. Very soon boats were observed approaching the scene of the disaster, having been dispatched to the locality from the different ships lying in the harbor, and also from the shore in charge of a crew of water-police, under the command of Mr. Inspector Donohue. By the assistance of these boats the crew—those who had been fortunate enough to get on board the lighters alongside the vessel—were nearly all removed at once to the Sailors' Home at Circular Quay. Some of them, together with Captain Murdoch, the commander, were taken on board the colonial warship Wolverene. They were mostly in a half-clad state, while others had scarcely a stitch of clothing about them, as they did not even have time, after being aroused from their slumbers, to obtain their clothes. On being awakened, a general rush for the gangways was made, and many of the alarmed occupants of the vessel were subjected to severe jostling in their frantic endeavors to escape, all on board being terror stricken by the suddenness of the disaster. At first it was believed that all on board had escaped, but ultimately it was discovered that five lives had been lost: those of the purser, refrigerating engineer, and three Arabs, whose bodies were recovered, and interred in Haslam's Creek Cemetery. The cause of the disaster had not been ascertained at the time of writing, but was believed to arise from too much coal having been placed on one side, causing the vessel to list. According to an account in one of the morning papers, the Austral had been busily coaling for some time from lighters moored alongside her. The coal, however, had been placed in the bunkers on the starboard side, which gave the vessel a list, and as the weight gradually increased, the water rose nearer to her lower portholes. These were, unfortunately, left open; and immediately they reached the level of the water a torrent poured into her, which no human skill could counteract. The vessel gradually filled and settled down into between forty and fifty feet of water, her decks being covered by probably two feet, and her masts being, of course, almost entirely above water. Our engraving represents the escape of those on board directly the alarm was given.—*Illustrated Sydney News*.

THE TUNNEL BETWEEN FRANCE AND ENGLAND.

SOME four or five years since a shaft of exploration was sunk in Sangatte, under the direction of MM. Potier and Lapparent, the geological structure being thereby ascertained. The present sinkings are over 2,000 meters west of the former sinkings and consist of two shafts at a distance of about 83 feet apart, the smaller or No. 1 shaft being 7 feet in diameter, and the grand shaft, or No. 2, being over 16 feet across. In the French shafts, as in England, it is only the lowest 100 feet of the gray chalk which is found to be impermeable and compact; and, consequently, the same course for the tunnel has been pursued as at Abbots Cliff.

The site of the French above-ground works presents all the familiar appearances of a coal mine in the north of England. The buildings are of red brick, lofty and well designed, having a frontage toward the sea of nearly 300 feet, and covering a superficies of about 2,500 square yards. Here is a fine engine house, with a Farcot steam engine of 100 horse power, working two sets of air compressors of the Colladon type for driving the Beaumont boring machine below ground. These air compressors are capable of compressing to two atmospheres 350 cubic feet of air, or 125 cubic feet to eight atmospheres of pressure per minute. For the steam engine there are three very fine boilers, 33 feet long and 5 feet in diameter, by Meunier, of Fives-Lille; the total heating surface amounts to nearly 250 square yards. The brick chimney is a lofty one, rising over 100 feet from the ground. The compressed air is conveyed from the compressors down the grand shaft to the boring machine by large wrought iron pipes. The other buildings above ground comprise a great store replete with materials for all needs, and three fine workshops of one story high, and each about 200 square yards in area, respectively appropriated to the forges, the fitters, and the carpenters. There are also offices for the engineer, assistant engineer, and chief mechanic; and an admirable well lighted drawing office overlooking the sea, beneath which the submarine driftway is now being rapidly pushed forward at about 30 meters, or nearly 100 feet advance per day. The means are being provided for doubling the engine and boiler power for the great pumping machinery over the the shaft No. 1, and for the hoisting machinery over the great shaft No. 2. The above ground site is on a small elevation above the sea level, and upon a low cliff composed of chalk and rubble, in which bones of the great fossil mammalia have occasionally been found; the actual mouth of the great pit being 31 meters, or 111 feet above low water mark.

The descent into the tunnel has to be made in true miners' fashion. Taking hold of the hauling rope with one hand, and standing on the edge of the slowly descending bucket, one can see the character and construction of the shaft, varying with the nature and circumstances of the strata passed through. Through the uppermost chalk beds for about 60 feet, the shaft is bricked round; after which the strata allowed a considerable influx of water, and this portion of the shaft is incased by masonry in the form of a polygon of 12 facets; after which, when the gray chalk is entered, the brick casing is resumed and continued for a further depth, until toward the bottom of the shaft and the level of the tunnel wood casing only is employed. The way in which the shafts were made and the details of the influx of water at the various stages are interesting. The smaller shaft, No. 1, was made first. The quantities of water which have been tubbed out from it by the casings of the shaft, are, by the experience of the sinkings—from surface to depth of 45 yards, influx from springs about 150 gallons per minute; thence to 50 yards, 180 gallons; from the next four yards

there was a great inpour of over 600 gallons, diminishing to 418 gallons in the succeeding eight yards, and 374 gallons in the following four yards; after which—namely, from 66 to 76 yards of depth—the water diminished to 23 gallons per minute. The total of water, amounting to 1,500 gallons per minute, is thus shot out from the subterranean works. The grand shaft was sunk at a different season of the year, and the quantities of water, singularly, were less than in the smaller shaft. In the upper 49 yards the influx was 2:5 gallons; thence to 54 yards depth, 616 gallons; and from this to the depth of 71 yards, the inflow was reduced to 220 gallons per minute; the total of water per minute stopped out by the casing of the shaft being 1,078 gallons. The masonry casing in the grand shaft is a polygon of 24 facets. The drainage pump which did service in the sinking of No. 1 shaft, is composed of a cylinder nearly 3 feet in diameter, having a length of stroke of over 6 feet, the prolongation of the piston being yoked to the force pump. Its delivery is more than 100 gallons, and, as it can make ten strokes per minute, its discharge can reach to 1,200 gallons per minute. From the bottom of the great shaft the way into the submarine works is through a tunnel of considerable dimensions, worked out of the gray chalk by the pick and by blasting with gunpowder in the usual way. No less than 167 yards about 12 feet square have thus been worked out. Beyond this the tunnel has been pierced for more than a quarter of a mile, circular in form, and 7 feet in diameter, by the Beaumont drill. The gray chalk beds are very wet, and now and then there are springs of perfectly fresh water, not saline in the slightest degree.

In the circular tunnel, sleepers are laid across the lower portion, and a railway of light iron rails is put upon them; the wagons for bringing the *debris* from the drill being pivoted so that their contents may be tipped into the bucket at the bottom of the shaft, where the rubbish is drawn up as in ordinary mines. The spring water running from the tunnel drift flows under the railway, and amounts to about 90 gallons a minute. It runs into a deep sump hole near the shaft, whence it is drawn up by the pump. It is perfectly pure, and fit for the service of a town for drinking supply. The number of men employed in the submarine driftway is twenty, and forty above ground. The submarine tunnel takes a curve in an easterly direction to avoid the geological disturbances at the Quenoes. The radius of this curve is about 3,000 feet. When this is completed, the tunnel will go straight toward England for the distance for which the concession has been granted by the French Government, nearly midway of the channel. Very recently in this boring the gault was run into, but this stratum has now been cleared, and the perforation is going on in the lowest portion of the gray chalk as before.

THE DECAY OF BUILDING STONES.

AT a meeting of the New York Academy of Sciences, January 22, Dr. Alexis A. Julien, read a paper on the decay of building stones in this city. Of the buildings of New York having stone fronts, 78·33 per cent. are brown stone, 8 per cent. marble, and 2 per cent. granite.

The days of the brown stone fronts are numbered, and a prominent architect has said they are of no more use in New York than so much gingerbread. A number of brown stone fronts less than ten years old already look frightful. Fragments fell from the Lenox Library, constructed of Lockport limestone, before it was finished. The frieze is now decaying. The obelisk is exposed to the blazing sun and biting frost, and will necessarily experience decomposition. The external agencies of destruction are various. There are chemicals, acids attacking the stone, carbonic acid from the atmosphere, and nitric acid, especially in the summer, when electrical phenomena are common. Stone is injured by the oxygen and ozone and the common salt in the air. Mechanical disintegrations of stone are caused by frost and variations of temperature of 100° in a year, and sometimes 70° in a day. The action of the wind alone, bearing particles of dust along with it, also has an effect. Dr. Julien found tombstones in Trinity Cemetery, mostly of red sandstone, dated 1681 and 1722, in fair condition, and he declared red sandstone to be vastly superior to brown stone. This was also true of Nova Scotia stone, which does not decay so quickly. The only permanent protection to buildings must be brought about by the use of mineral compounds in solution. Insurance men believe there is not a single fire-proof building in the city in which the stone will not crumble in a fire. The Capitol in Washington, made of Potomac marble, is crumbling, and nearly all the marble buildings of Italy are affected by disintegration. What will become of the obelisk is shown by the fate of the obelisk in Paris. In New York, the northern and eastern parts of a building are affected by decay, while in England it is the southern and western sides. In the Mall at Central Park the freestone mouldings have had to be repeatedly recut.

GREGYNOG HALL, MONTGOMERYSHIRE.

THIS mansion, from the designs of Mr. W. Eden Nesfield, is shown by one of the author's own spirited drawings. The general features of the house are simple and unpretending, but stamped throughout with the beauty which has always distinguished the works of this architect.—*Building News.*

RECENT FIRES AND THEIR LESSONS.

THE recent almost unparalleled succession of great fires throughout the country, and especially those which have destroyed the Alhambra Theater and the warehouses in Wood-street, and partially ruined Hampton Court Palace, may well alarm many who have hitherto supposed that our Metropolitan Building Act and Fire Brigade rendered the destruction of London by fire an improbable casualty. Hardly had the fire in the Alhambra spent itself from sheer lack of fuel, when the Wood-street catastrophe occurred; and the thought naturally forces itself upon one's attention, with alarming significance. What would be the consequence if half-a-dozen conflagrations of the same kind broke out simultaneously? As it was, the whole strength of the brigade failed to check the destruction of the warehouses in the City, and it was taxed severely to confine the flames. Only last year Cheapside was the scene of a conflagration not quite so extensive, which took place at the corner of Bread-street, and which served as a text for some remarks we made at the time; and not long before we said, when referring to the neighborhood of Wood street, that it offered all the conditions required for a great and disastrous conflagration. We claim no credit on account of our unfortunately fulfilled prediction. Any one accustomed to fires, and viewing with natural apprehension such facilities as are offered for their outbreak in the more crowded business quarters of the City, might have made it. The streets are narrow, the warehouses, in close quarters, are several stories in height and built on a principle which invites ignition and rapid combustion, while they are stocked from basement to roof with combustible materials. We surely must think with serious misgivings of the possible sacrifice they might have caused. In the case of the Alhambra one is appalled at what the consequence would have been if the performance had been in progress and the house filled. The record would have been distressing beyond description—if anything, even more sad than the fate which befell the Brooklyn Theater.

The facts already made known have not cleared up the origin of either of the great fires referred to. According to one account, the fire of the Alhambra originated in one of the front refreshment-rooms, and may supposed to have been caused by a lighted end of cigar thrown away. It was easy to have extinguished the fire at an early moment, as it was possible to have saved the greater portion of the build- have, from time to time, dwelt on the necessity of carrying out the division of risks recommended by Captain Shaw, by the separation of the different portions of a theater by fireproof walls and partitions; and we lately drew attention to the requirements of the Metropolitan Board of Works, and the Lord Chamberlain. As showing the value of dividing theaters into practically separate parts, it may be noticed that the painting-room at the Alhambra, which had fireproof doors, was not injured. Even the provision of thick wooden doors lined with sheet-iron has had the effect of checking the rapid spreading of flame, and so giving a chance to the firemen of arresting the destroying element. Wherever there is a draught, a fallen cigar, match, or a smouldering bit of paper may be speedily fanned into flame, and the building, without division into parts, becomes an admirable grate for ignition and rapid spreading of fire. The Alhambra was a large unencumbered interior, full of draughts, and fulfilled the conditions; once alight, it became a blazing furnace. The disastrous effects of the fire may be realized by a visit to the ruins. The front wall only remains to screen the devastation behind it. Here we find girders thrown about and twisted into all shapes—evidence of the intensity of the fire, and the effect of a body of flame playing upon them as if from a blow-pipe. Had these girders been incased in fireproof concrete, had the columns been surrounded by a casing of plaster, and the galleries constructed of incased rolled beams, on a system like that of the Dennett arching, and had the vast dome and roof been constructed of fireproof materials overlaid with asphalt, we might have been spared the spectacle now to be witnessed in Leicester-square; but even these preventive measures were not carried out at the Alhambra.

The great fire in Wood street, Cheapside, has resulted in a loss estimated roughly at about £2,000,000 to £3,000,000, and its interest to architects is increased by the fact that the warehouses destroyed were comparatively modern buildings, if not perfectly fulfilling all the conditions of the Building [illegible]. The exact area was a quadrangular site, or block of

SUGGESTIONS IN ARCHITECTURE.—GREGYNOG HALL.

buildings, bounded on the north by London-wall, on the west by Wood-street, and by Addle-street and Philip-street on the south and east sides. The Wood street frontage was the greatest, measuring about 380 feet, according to Capt. Shaw's report. Within this area there were various warehouses, many of them of five and six floors, and extending a considerable depth. This mass of buildings in a very short space of time became hopelessly involved in the original fire. The rapid spreading of the flames is the most instructive point of the calamity. Within a few minutes flames were seen bursting from every window of the warehouse just discovered to be on fire, and the whole interior seemed to be alight from top to bottom; soon the roof caught, and the flames curling over, ignited the adjoining warehouses, even in spite of the operations of several steamers. There must have been something radically wrong about the construction of these buildings which caused them to fall such an easy prey to the flames, and it is essential to know whether the party-walls were sound, and of sufficient thickness to withstand the heat; how the floors were constructed, and whether proper means were taken to close the communications from floor to floor. The officials of the brigade assert the warehouses were peculiarly built, in the well shape, and were not properly cut off from each other. It is not unusual to find a central opening left in the floors for stairs or lifts, and trapdoors omitted. Under any such circumstances, we cannot be surprised at the rapidity with which the flames mounted upward and ignited the roofs. There was, indeed, one notable exception to be mentioned. The Curriers' Hall had a flat fire-proof roof and thick party-walls, and owing to these conditions, escaped the general conflagration. Zion College also was preserved from serious damage. Other premises in Wood-street and London-wall were saved by apparently the same precautions; and it will be a matter of investigation for Captain Shaw, in his detailed report, to discover in what respects those buildings differed from the others in points of construction. In London-wall, a large warehouse of several floors was burnt out in the inconceivably short time of five minutes, and only two walls remain to tell of its existence. Although the fire, by desperate efforts, and a timely arrival of the brigade, was confined within the area in which it began, the houses and buildings surrounding on opposite sides of the streets were damaged more or less. Those on the opposite side of Wood-street were injured by falling masonry and *debris*, and in Addle-street and Philip-lane the fire not only scorched the fronts, but actually destroyed the floors and roofs of premises. One incident of importance to mention, as proving the unreliability of stonework to resist fire, was the falling of the masonry from the top of the warehouses in Wood-street, and the imminent danger caused thereby to the firemen. Large blocks of calcined stone fell into the street, till it was choked up with the *debris* thus occasioned. The very treacherous nature of stone cornices and copings, window-dressings, and the like, when subjected to intense heat, ought to afford a timely lesson to builders of warehouses, and the disaster, we hope, will lead to the more general recognition of the value of concrete or terra-cotta for such portions of buildings. Captain Shaw has before called attention to the very uncertain resistance of stone staircases and stone fronts to intense heat, and let us hope the lesson which this fire has furnished, added to the even sadder experience gained when Messrs. Foster's premises in Cheapside were destroyed, will not be learnt in vain. In the latter instance, the stone fronts were completely reduced to quicklime and crumbling masses; all the details were effaced, and only the core of the stone facing was left. We have a new source of danger here as long as the calcined walls remain standing.

We are naturally led to inquire whether the provisions of the Building Acts are complete enough to prevent a recurrence of such calamitous and destructive fires. We lately drew attention to the provisions required by the Act under sections 22 to 28, and the recent amendments. The limitation of the areas of buildings, especially warehouses, is probably one of the most important of these. The statutory 216,000 cubic feet for warehouses is itself a large space in which a fire not under control can be allowed to burn. As regards the Wood-street warehouses, it would be interesting to know if any of them exceeded this limit, and if any of them were united. Joint occupation is sometimes the cause of great difficulty, for openings in party-walls are not uncommon, in spite of the clause that no buildings in the same occupation are to be united; and when such openings are not provided with wrought-iron doors, according to section 28, the statutory clauses relating to party-walls become a dead letter. Sometimes floors divide the occupations, and it is very necessary in such cases to have fireproof flooring, or a layer of concrete or asphalt over it. With regard to staircases and lifts, the provisions of the Act are not quite full and comprehensive enough, and much is now left to the discretion of the district surveyor.

The disastrous fire at Plymouth, which destroyed the Presbyterian Church, recently, has a special significance. In this case a modern stone church, with walls of limestone, and constructed in the usual manner, with galleries round three sides, was entirely burnt out in three or four hours. The schools and classrooms formed the basement. About an hour after the fire was discovered the roof fell in, and the floor and galleries soon gave way, and so completely was everything consumed that the four walls are only left standing. In this instance, as in many others of church-burning, there was something wrong with the heating apparatus. Perhaps the flues were foul, or over-heated, or the fuel was too liberally put on. We hear the church and schools were heated by means of an apparatus, hot-air pipes being laid between the floor of the church or aisle and school-room ceiling. These pipes were supplied with hot air from a furnace fitted at one end of the basement. It had worked remarkably well. The furnace was found to smoke a little, but this was seen to. We are not informed how the flues were formed, and whether they were properly incased in fireproof material; suffice it to say the schoolroom was found to be in flames, as also the aisle of the church in the neighborhood of the hot air pipes. There can be little doubt as to the cause of the fire. We are concerned more with the rapid destruction of the whole edifice. The roof, from what we can gather, was of timber, with a hollow space between the paneled ceiling and the outer covering. There is always a a risk in the introduction of hot-air flues in a building of wood, and the catastrophe may have a useful lesson for church-builders and heaters. The fire at Dumbarton, by which the town buildings were consumed, affords another instance of a fire spreading with alarming rapidity, defeating all efforts to check its progress. The buildings comprised a school for 600 pupils, and two large and other smaller halls. We hear the fire originated from a careless workman, who, with a lighted candle, had come in contact with some felt which was being laid on the roof of some new classrooms.

In all of the buildings destroyed, the rapid progress of the flames is the chief point of remark. Every building with inflammable materials and contents is liable to suffer from fire; but if the risk can be reduced to a small compass, or if the flames can be temporarily restrained within certain limits, there is a chance of saving the mass of the building and its contents, and allowing of escape. In the fires we have mentioned there was a lamentable neglect of this principle of subdivision of parts. But there were other weak points. In nearly all of them the roofs were of timber, and constructed on the best method for rapid combustion. In both the Alhambra Theater and Wood-street warehouses the flames soon found an opening, and the fate of the interiors was sealed. In the Curriers' Hall a more compact roof, flat and covered with an impervious material, prevented the penetration of the fire, and was saved. We do not hesitate to say that had these warehouses been roofed in with some impenetrable material like Claridge's asphalt, or their ceilings rendered impervious by a thin skin of the same material, the fire in Wood-street would have been confined within certain limits. The only absolute safeguard against the extension of such disastrous fires, and destruction of life and property, is the compulsory separation of large buildings into sections by concrete floors and partitions of brick. All openings ought to have fireproof doors of wrought iron or of solid plank covered with tinned sheet-iron, as we lately noticed, and these ought to be enforced in the construction of warehouses with lifts and staircases. In theaters the inflammable materials, scenery, and property may be rendered fireproof, as pointed out in a letter in the *Times*, the other day, written by Mr. Boucicault. By this process, wood and textile fabrics can be rendered incombustible at a small cost. A fireproof paint in which very similar ingredients enter we described the other day; the principal of which are pulverized glass, porcelain, and lime, with water-glass or silicate of soda. Then there is the asbestos paint to which a Birmingham correspondent has called our attention, which well protects woodwork at a comparatively trifling cost. Any improvements in construction deserve serious consideration just now. Among them one which seems worth attention is an idea which Mr. J. M. Hooker, architect, of Sevenoaks, has just patented and brought under our notice. He proposes to use, instead of the ordinary floor girders, box or hollow girders, of which all on each floor communicate with each other. In each girder he forms through its sides rows of holes, preferably shaped as horizontal slits, and connects the interior with a water main, provided with a suitable cock, valve, and hydrants, which, in case of fire occurring in any story, could be opened so as to admit water to the interior of the girders immediately above that story. The water, Mr Hooker thinks, would keep the girders cool, and overflowing through the holes in the sides of the girders descend on the burning material below, so as to extinguish it, or at least prevent the spread of fire. In the cases where buildings are already constructed with girders not hollow, water-pipes might be fixed along them, these pipes being perforated, so as to direct jets against the sides of the girders. Where tubular iron columns are employed, they might be also charged with water to keep them cool, and might be employed as channels conducting water to the interior of the girders, or to the perforated pipes. More stringent supervision is demanded also in the erection of large theaters and warehouses, and some rules for the nightly supervision of such buildings, whether occupied or not.—*Building News.*

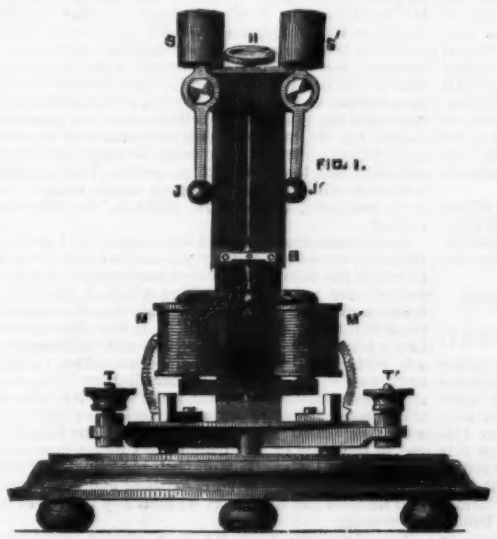


FIG. 1.

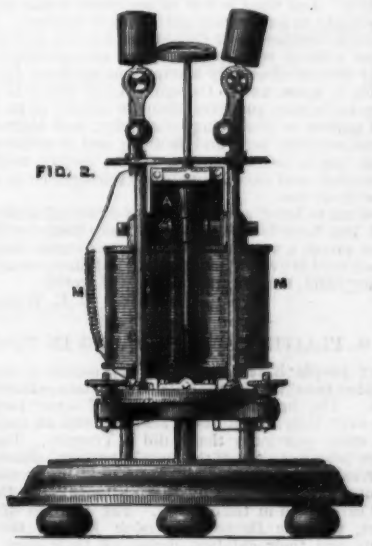


FIG. 2.

BRIGHT'S IMPROVED TELEGRAPH SOUNDERS.

NEW TELEGRAPH SOUNDERS.

It is now nearly thirty years since the "Bell instrument" was introduced by Sir Charles Bright upon the lines of the old "Magnetic" Telegraph Company. This was practically the first acoustic telegraph, and as it had several important advantages over an instrument read by sight, it rapidly superseded the needle instruments of Henley and Foster, then used by the company. In receiving a message read by the eye, two clerks are necessary, one to read and call out the words, another to write them down.

Besides the extra assistance required, the chances of error are thus multiplied, such words as "two" being sometimes written for "to," or "four" for "fore." With the Bell instrument, on the other hand, the clerk who read the message by ear could write it down at the same time. It was less trying to the eyes, and while workable with a smaller staff, it gives a higher rate of transmission than the Morse instrument, because, being worked by positive and negative currents like a needle instrument, the signals were all of equal duration. This fact gives it even now an advantage in point of speed over the modern "sounder," which is worked by "dot" and "dash" currents. From thirty-five to forty words per minute can be sent by it, and it remains the most rapid of hand-operated telegraphs in the postal system, where there are still some two hundred and fifty in use.

The acoustic telegraph has been growing in favor of late years under the form of the American "sounder," which is simply a Morse instrument with the inking apparatus removed and the armature of the electro-magnets made to click between two metal stops. These stops are the counterpart of the two metal plates in the Bright Bell instrument, for, though the latter originally derived its name from two bells of different tone hit by the electric hammers, the ringing sound was found to be less effective than a deader note, and metal plates were substituted in the later patterns. Probably the best sound would be the golden mean between the hard click and the full chime. In the new sounders of Sir Charles, Bright this middle sound appears to be realized. The plain stops of the ordinary sounder are replaced by tubular anvils of Muntz's metal, and the strokes of the message are clear, sweet, and mellow, yet not ringing. The new apparatus has other practical advantages in the large size of the hammer or tongue which beats upon the hollow anvils, thus enabling the operator to see as well as hear the message if he chooses, and in the fact that it can be worked either with reverse currents as in the single needle instrument, or with the ordinary Morse dot and dash signals of the same current.

The "signal" sounder, as it is called, is illustrated in Fig. 1, which is a front elevation of the instrument. There M M^1 are two like poles of an electro-magnet, which is connected by the terminals, T T^1, in circuit with the line. Between these like poles there is a ball-headed armature of soft iron, A, which is pivoted at B, and hangs vertically between the poles by reason of its weighted head. This iron armature may be unpolarized, but it is usually polarized oppositely to the electro-magnet poles on either side by contact at the pivot with a projection of the lower poles of the magnet. Above the pivot it carries a long light arm of aluminum, having at its upper end a flat ring, H, of Muntz's or other sonorous metal, which rests between two hollow tubes of S S^1 of a similar metal. The ring, H, is the hammer end, and S S^1 are the sounding stops of the instrument, which, when struck by the hammer, give out notes of different pitch and quality.

The action of the signal sounder will be readily understood. When it is arranged for needle signals, the hammer stands at rest midway between the two anvil stops, S S^1, and beats to right and left on one or other according as the current sent is positive or negative. But when the sounder is worked with Morse currents, the hammer has its rest position in contact with one of the stops, say S, as shown in the figure, and the long or short currents of the same name kick it over into contact with the other stop, S^1, thus beating out the message.

The stops are pivoted, and can be adjusted by moving the handle, J J^1, thus obviating the necessity of shifting the magnetic parts of the apparatus. Fig. 2 is a modification of the signal sounder, which fits it for relay purposes. The armature, A, is supplied with an adjusting spring at its lower part, and the soft iron is polarized by contact with a curving projection of the lower poles of the electro-magnets, M M^1. The upper pole-pieces of this electro-magnet are carried by adjusting screws, in order to adjust the play of the armature; and platinum contact studs are attached to the sides of the hammer and tubular anvils. Such a sounder, besides giving out an audible message in the ordinary way, can by means of a local circuit and recording instrument leave a permanent copy of it on black and white. For railway, colonial, or military work, and for country post-offices, it appears to us to be well suited, and to have advantages over the ordinary sounder. For example, it is readily adjusted, the parts are easily kept clean, and the peculiar sounds of the stops cannot readily be mistaken for any other noise. They have a *timbre* of their own, which the ear can readily distinguish from either sounds, and being also loud and distinct they are particularly suitable for railway office and signal boxes. Moreover, the instrument is very sensitive to the current, and would work on defective lines, when the ordinary sounder must perforce be silent. The instrument shown in Fig. 1 can be operated by one Leclanche element working through a resistance of 2,500 ohms, or, in other words, through about 200 miles of land telegraph wire. The resistance of the electro-magnet in this instrument is about 400 ohms; and that of the relay sounder shown in Fig. 2 is about 200 ohms.

We understand that the postal telegraph engineers are now trying these instruments on the Government lines, and it would be satisfactory to know that their capacities for railway working were also being tested.—*Engineering.*

POMPEIIAN SURGERY.—A collection of surgical instruments has been discovered at Pompeii and removed to the Naples Museum. It evidently belonged to one establishment, and is as large an equipment as the modern surgeon is supplied with. One of the instruments is a long rod with a metallic plate fixed at one end at an angle of 135°; it was first thought to be a cautery for internal operations, but its resemblance to the modern laryngeal mirror suggests the possibility that it was employed in a similar manner.

ELECTRICITY THE PROPELLING POWER OF THE UNIVERSE.

As I arrived in Detroit some time since, at the foot of Jefferson Avenue, I observed the electric light up the avenue. The night being dark and foggy, the effect of the light was indeed striking; and as the appearance was so much like the rising sun, the idea at once took possession of me that the electric light and the sun were closely related, and that the electric light is the only light ever produced by man, similar to the sun's light. We all know that the sun is the great center of our solar system; that it defines the orbits of the planets, supports them in space by its attraction, and, I will add, propelling power. We also know that the earth rotates on its axis every day, and makes a periodic revolution every year. *But why those revolutions?*

I have never been able to find in any printed work an explanation. Perhaps to ask why has been thought too much like asking Who made God? But as the sun is the great center of attraction, it is also the great center of electricity; the great reservoir of electric force. If we may speculate, let us suppose it sends out a constant uninterrupted current or stream of electric force, coming from the sun to our earth, which passes through vacant space with the utmost ease, until it meets our atmosphere; then it encounters a resistance which creates a friction causing heat, and the heat produces light. Light cannot travel from the sun, 95,000,000 or 93,000,000 miles, in eight minutes. Electricity is the only force that can so travel. In this manner we obtain our light and heat from the sun without lighting and heating all the infinite vacant space, which is cold and comparatively dark, which it would be as foolish to heat as for us to try to warm all out doors in warming our own dwellings.

As nature does everything with the utmost wisdom and *economy*, let us look to nature, but not for any foolishness. This electricity also electrifies positively the one half of the earth toward the sun, while the other half is electrified negatively, producing an electric current round the earth, traveling with lightning force and speed, caused by nature's effort to restore the electric equilibrium, which would sweep everything from the face of the earth, were not the earth made by it to rotate in the same direction on its axis; also to travel round the sun in the same direction, all from the same power—electricity. Also all our daylight is electric light positive, and what light we get by night is electric light negative, except what light we receive from the moon, which is positive. And what is true of our earth is true of all the other planets in our system and all other systems. Also, it must not be supposed that the sun can forever give out electric force without receiving in return an equivalent, which it surely does by electricity leaving our earth at the poles, returning to space, and to the sun. As all matter in space is tending to the sun, and everything in nature is in motion, and all motion is producing electricity, and electricity in turn can produce heat and motion; and as nothing in the material can be lost, so nothing in the electric world can. Heat, motion, and electricity are interchangeable in nature's plan, without loss.

Allow me to infer, as the result of a careful study of the subject, that there is surely no other force than electric force that can propel a universe. With it the Creator reaches everywhere (and is everywhere present), vitalizes, energizes the breathing form, and controls millions of worlds.

L. E. WOODARD.

STRAW PLAITING AND WEAVING IN TUSCANY.

MANY people have never heard of Tuscany in any other connection than with straw hats and certain political revolutions. The braiding and plaiting of straw long since spread over Italy, but it never reached such an importance in the other provinces that it did in Tuscany. There this industry belongs to one of the most important, although it is not carried on in large factories but remains a "home industry," much as cigar making is with us, except that it is mostly carried on in the country. The families of farmer laborers, says the *Deutsche Industrie Zeitung*, the female peasants, and their children devote all their spare time to braiding straw, the product being sold to dealers through traveling agents, called *fattorini*. The factories are exclusively employed on making hats. The straw plaiting of Tuscany is of very ancient origin and can be traced back for several centuries. There are no definite records of the exact time when it began nor of who originated it, but as early as the fifteenth century straw hats were subject to tax.

The place to which the straw industry owes its existence is not accurately known, but it is generally assumed that Signa, in the neighborhood of Florence, was the cradle of straw plaiting. On a monument of the eighteenth century it is recorded that Michelacci of Signa, gave a great impulse to the straw industry there by the introduction of the cultivation of a new cereal, *grano marzuolo* or March grain. This grain has an extremely fine, pliable, sulphur-yellow straw, excellent for braiding and plaiting, thus promoting this industry.

The cultivation of this plant naturally spread very rapidly, not only in Tuscany but all over Italy. Although the straw industry connected with it paid quite well, the profits were very variable because the finished product—the hats—were subject to all the changes of fashion. Until recently, that is, while Florence was still the capital of Italy, only the so-called *Fioretto* (broad-brims) were made there. But these hats were not always in equal demand, and they suffered a severe competition from the introduction of hats made of rice straw. This was again met by a Signesian named Carbonari, who succeeded in introducing the Florentine hats into France and Germany at the beginning of this century.

The acme of its success was first attained when a transatlantic market was opened for their wares. At this time the demand increased to such an extent that more than eighty thousand persons, who had previously given only their spare hours to this work, now gave their whole time to it. These palmy days lasted till 1826, when unrelenting fashion dropped the Florentine hat entirely, and it was generally believed that the victorous industry was permanently suppressed, but a fresh impulse from England helped it to rise again. An English company called "Wyse" introduced a new kind of straw hat into Tuscany that was not previously known there; instead of being all woven in one piece like the Florentine hat, it was made of straw braids sewed together. This company took every care to spread this new kind of manufacture, not merely by founding braiding schools, but also by the introduction of specially constructed machines which cut the straws all one size and length, whereas they had previously been selected by the eye alone. Hereafter only four meshes were woven with the four or five inch straws, but all the straws in one braid were of exactly the same color, white straws being entirely discarded. These straw braids were able to defy every change of fashion. At the present day straw braiding is still growing in Tuscany; it supports over one hundred thousand people and brings into the country over fourteen million lires, or nearly three million dollars.

When the straw is to be used for braiding, the grain is sowed on poor soil. Immediately after harvesting, the straw is selected, picked out, cleaned, and tied in bundles. The latter are put in a dark place where they can be constantly dampened with water and exposed to the action of sulphur fumes. After a certain time these bundles are put in the sun to dry, and are then cut in pieces four or five inches long. From these little straws braids forty inches long are made, those that are shorter having less chance of sale because a length of one meter was decided upon by a convention representing both the straw weavers and the chambers of commerce.

As already stated, Tuscany is no longer the only seat of the straw industry, which has spread over the whole of Italy. The Tuscan and Florentine manufacturers still hold the front rank in spite of foreign competition as well as that of other parts of Italy.

Formerly the straws were exported, but now the braids are commonly in demand, because other countries find the latter the most profitable, owing to the price of labor in Tuscany being lower than in other countries. For a long time France tried to compete with Italy in her own provinces that bordered on Italy, but she did not succeed, and now she has abandoned the attempt. In fact there is no other country where the straw industry has been so successful as in Tuscany. This depends in part on the skill of the workmen and in part on the quality of the material. This seems to justify the general assumption that her soil is better adapted to the cultivation of this particular grain.

FLEXIBLE TISSUE FOR DARK ROOM WINDOWS.

THE chromate of silver film forms a most admirable protection against actinic light while preparing or developing gelatine plates; indeed, I question whether any other ruby medium—whether glass, paper, or silk colored by different means—affords the same protection while giving an equal amount of light.

But while the color is all that can be desired, I think that Mr. Stewart's support can be improved upon, at least for the purpose for which he specially commends it—the dark tent. Dry gelatine films, if of a thickness to bear handling with anything like roughness, possess considerable brittleness. Certainly they may be bent and doubled and folded without breaking, but if a sudden transverse strain be put upon the film, it will break in an irregular manner that can scarcely be described as "tearing." By the addition of certain substances to the gelatine, the brittleness is to a great extent removed, but Mr. Stewart makes no mention of any such addition; hence I fear that, even with the extra protection of the collodion film, the copal varnish, and the Turkey cotton, such a window will scarcely bear much rough usage. For dark room purposes, however, the films he describes would be perfect.

Some years ago, in the old wet plate days, I used a colored tissue for the window of my tent and also for my dark room, in which the coloring matter was chromate of lead (chrome yellow), the method of making which I obtained from a friend now dead. The basis of this was fine cambric. To convert it to the desired purpose, it was dipped, first of all, into a solution of gelatine (or glue) and bichromate of potash, with a little sugar and glycerine added to destroy the brittleness of the gelatine. After dipping into the bichromated gelatine the tissue was hung up to dry, after which it was treated with a solution of acetate or nitrate of lead, which deposited the chrome yellow in the film of gelatine and in the body of the cambric. I forget now the proportions of the materials employed, but the result was a very durable and efficient window—strong and flexible enough to fold up with the tent cover without any danger of breaking or creasing.

Some time ago, when Mr. W. K. Burton recommended the emulsion of chromate of silver for dark room windows, it struck me that that salt applied to cambric in the manner I had formerly been accustomed to would form an equally efficient blind for the dark room or for traveling purposes with gelatine plates. I therefore put it to the test, and have been perfectly satisfied with the results. My mode of procedure was as follows:

One ounce of hard gelatine or good Scotch glue, two drachms of glycerine, and ninety grains of bichromate of potash were dissolved in a pint of water, and while hot poured into a deep flat porcelain dish about 12 × 10. The cambric, previously dipped in warm water and wrung out, was then immersed and worked about with a couple of pieces of stick, in order that the whole of the fabric might absorb as much of the viscid solution as possible. One edge of the tissue was then straightened out and tacked to a lath without removing any more of it from the gelatine solution than possible until the tacking had been completed. By means of the lath the sheet of tissue was then dexterously lifted from the dish, allowed to drain, straightened out, and a second lath tacked to the bottom edge, the whole being hung up in an obscure place to dry, which it did with very little puckering.

When dry, it was treated with a ten-grain solution of silver nitrate. I used an old bath diluted. For small pieces, the best plan is to float; brushing the solution over is liable to cause streaky marks—not so much marks of unequal density as sharp lines similar to those left on a collodion plate if it be arrested in dripping into the bath. For large pieces—fifteen or more inches in dimension—I constructed a wooden trough the length of one side of the sheet, and lined it with black varnish to render it water tight. Into this I poured the silver solution, and taking the tissue by the two laths upon which it was dried, I formed it into a loop or bow, in which I placed a stout wooden roller about an inch and a half in diameter. Allowing the roller to dip in the trough of silver solution, by raising and lowering each hand alternately, I was enabled to pass the whole surface evenly through the solution until the whole of the bichromate had been converted. A thorough rinse in water completed the operation, and the tissue was again hung up to dry.

A small proportion of nitrate of lead may be used with the silver, if a more orange color be desired, but as this adds greatly to the *opacity* of the tissue, it is questionable whether it is an advantage.

In conclusion, though my tissue is, perhaps, not so transparent as Mr. Stewart's, it is quite sufficiently so for all purposes—indeed, as transparent as any of the commercial colored media; while I think it will bear the test of hard work better than the gelatine film.—*C. Beckett Lloyd, in The British Journal of Photography.*

ON TEACHING ORGANIC CHEMISTRY.

By Prof. EDWARD J. HALLOCK.

IF chemistry in general is a difficult subject to teach and a dry one to learn, this is especially the case with that branch known as organic chemistry. The necessity of teaching it in high schools and colleges is beginning to be felt, but how it is to be taught it is more difficult to say. As usually taught, it is a mere matter of memorization; a list of complicate chemical formulæ with a string of unpronounceable polysyllabic names is presented to the learner, and he is invited to swallow them first, and take the chances of being able to digest them at some future time. Text books on organic chemistry are of two kinds, the one filled with a collection of facts, figures and formulæ; the other devoted to theorizing, and stuffed full of hypotheses, with algebraical symbols and geometrical diagrams to illustrate how elements may *perhaps* combine. Admitting the insufficiency alike of oral and of text book teaching, organic chemistry has been assigned to the laboratory, and, whether aided by lectures or not, the student gets his first insight into its mysteries there. In this, organic chemistry scarcely differs from any other branch of chemistry. The composition of bodies may be learned by rote, their nature and properties can only be learned by contact.

A very simple laboratory will suffice for all except the most difficult operations of organic chemistry, but it needs to be quite differently arranged from those now in use for inorganic work. One of the plainest and simplest laboratories for organic research, and yet one of the most efficient is that of Prof. Ad. Wurtz, in the Ecole de Medécine, in Paris. In all laboratories gas must be abundant and under sufficient pressure, which can usually be obtained if large service pipes are used. Water must be plenty and well distributed everywhere, so that distillations can be carried on conveniently at all times, and in many places, out of doors as well as in. Water pumps and aspirators are desirable, and a "bomb-proof" indispensable. The usual sinks, draughts, hoods, water and mercury baths, combustion furnaces, blast-lamp, etc., are, of course, required, and a good chemical balance. A considerable quantity of glass and porcelain will be required, but of quite another sort from that used in other laboratories.

To obtain the best results there should be a teacher to guide and direct the work. This is not generally the case, the student being thrown almost entirely upon his own resources. Of course, boys do not begin organic work until they have reached the years when they ought to have discretion, but even then, in a new field, it is well to have a guide. Good chemists are rarely good teachers, and *vice versa*, hence the difficulty of securing the right sort of men for these places. Generally the position is a mere stepping stone, and is only held until a better offers, or else the teacher is too occupied with other work to give any attention to the student. We know whereof we speak, when we say that this is an evil not confined to any particular country or nation. It promises, however, to diminish in this country as the number of organic chemists increases.

Having obtained a suitable laboratory, with or without a teacher, it remains for us to decide upon some systematic line of work to be done. Here, again, our experience in other laboratories is of comparatively little assistance, for different subjects require different treatment. The student of inorganic chemistry usually begins with qualitative analysis, in which he learns the properties of the leading metals and their salts, and, in fact, learns to recognize most of the elements when combined. In organic chemistry most compounds consist of but two or three elements, and qualitative analysis has scarcely any application to organic chemistry. Testing for proximate principles, like starch, gum, and sugar, or learning to recognize the various alcohols, ethers, and acids, would be a valuable drill, but proximate organic analysis is yet in its infancy, and has not been reduced to a system that permits of its being carried out on the plan of mineral analysis. At present a qualitative analysis of an organic mixture often baffles the skill of the most experienced analyst. It is evident that it would be unfair to set a beginner at it.

In mineral chemistry the blow-pipe often does good service and shortens many a tedious test; in organic chemistry it has no use except to determine mineral elements. The flame test for chlorides, bromides, and iodides is the only one in common use.

The quantitative analysis of an organic body may be either proximate or ultimate. The first applies only to mixtures, like finding the amount of sugar and alcohol in wines; the second only to simple substances, such as finding the percentage of carbon and hydrogen in alcohol. The latter is a simple operation, and, being done in the "dry way," is well adapted for an initiatory exercise for beginners. It is exceedingly important that a chemist be able to make an accurate and reliable ultimate analysis, for which purpose he must make a sufficient number of "combustions" of pure substances, both solid and liquid, such as sugar, oxalic acid, alcohol, benzol, turpentine, chloroform, ferrocyanide of potassium, urea, etc., to gain experience in it. Whether this shall be the first exercise given him to do will depend on the director of the laboratory, who should also take into account the weather, and allow these analyses to be made in winter or early spring.

In some American laboratories students take a preliminary course of experiments before taking up qualitative analysis. This usually consists in making oxygen and other gases, in preparing nitric and other acids, in purifying and crystallizing metallic salts, and in thus learning chemical manipulations. This course is the only one performed in the inorganic laboratories that can be closely imitated in the organic laboratory.

In most of the German laboratories the student is set to prepare various organic compounds, ethers, esters, or salts, so as to become acquainted at the same time with their properties, and with what is equally important, the methods of making them.

A little book, by H. C. Jones, has recently appeared, in which are described a number of suitable experiments in organic chemistry, that may be safely performed by the student at his desk. This book will be found useful to students that have no teacher, and prove convenient for teachers who have not the ingenuity to invent a similar course. It is not necessary to follow the order of the book; the experiments can be varied to conform with any text book that the teacher prefers. Unfortunately, no complete work exists giving the best method of making all sorts of organic compounds, but assistance can be had from Attfield, the U. S. Dispensatory, Watts' Dictionary, and especially the original papers of the men who discovered the substance, when they are accessible.

After the student has been through a course of simple organic experiments, making hydrocarbons, alcohols, and

ethers, and preparing the most useful reagents, such as acetyl chloride, methyl and ethyl iodides, absolute alcohol, ethyl sulphates, and the like, it is well to take up a special class of reactions. The most useful of these are nitrification and reduction. Take benzol, for example, and convert it into nitro-benzol, then *reduce* this to amido benzol (aniline), and afterward convert the latter into rosanilin. Instead of benzol, phenol or other aromatic substance can be treated in like manner. This series of operations is very instructive. To undertake the investigation of a new and unstudied substance without the advantage of this preliminary acquaintance with methods, is like trying to make an analysis of an unknown substance without ever having analyzed a known substance. It is like a man who attempts to invent a locomotive without ever having seen one; men of extraordinary genius succeed, but others meet discouragement at every step, though they may succeed at last.

An excellent method pursued in some laboratories, consists in allowing a student who has satisfactorily performed the various operations above described, to repeat the classical investigations of some distinguished chemist, such, for example, as Wurtz's discovery of glycol, Hofmann's preparation of the organic ammonias or mustard oils, or the equally well known investigations of Kolbe, or Kekule. Taking the published papers of these men, the young chemist repeats each step as if engaged in an original research of his own. Thus he meets with each of the obstacles encountered in an original investigation, but here he has the advantage of knowing that they can be overcome, because in this very case they have been conquered, and the combination that he sets out to make is a possible.

Although this will seem a tedious route for one who is in a hurry to distinguish himself by original brilliant discoveries, he will find it the old story of the hare and the tortoise.

In some organic laboratories where technical instruction is the special aim, large apparatus, steam boilers, and autoclaves are at the disposal of the student, who repeats manufacturing operations on a moderate scale, using several pounds of material, so as to gain an insight into the practical workings of a process. This is not feasible in a college course, but very useful in a technical school, for it often happens that operations which work nicely in a test tube fail to prove profitable on a manufacturing scale; while on the other hand, owing to the use of steam heat, high pressure, vacuum pumps, and other powerful apparatus, some chemical operations go on more smoothly on a large scale than on a small one. An hundred weight of starch can be converted into glucose more quickly and easily in the factories than an ounce can be in the laboratory. The preparation of artificial salicylic acid from carbolic acid is not easily performed as a laboratory experiment, but is a grand manufacturing success. As a rule, the preparation of artificial dye stuffs from aniline, carbolic acid, anthracene, etc., can be accomplished on a large scale or a small one with nearly the same facility, so that a patent is frequently taken out and the process sold for a large sum, when less than an ounce of the dye has actually been made. It is not advisable, however, when attempting anything new, to work on a very small scale. When Hofmann began his investigation of bases in coal tar, he started off with *half a ton* of raw material, and from that he obtained *four pounds* of the crude bases, less than half of which was aniline, the substance destined to revolutionize the color industry.

When a student has familiarized himself with well known reactions and operations, and wishes to enter upon an original research, having selected a subject—and in this he will need the aid of a widely read chemist—he must next ascertain what has already been done in that line. This involves a somewhat tedious search through all the literature of the past, nor is the literature of organic chemistry a meager one. A single chemical society, that of Berlin, issues two volumes of transactions, of one thousand pages each, every year. More than half of this is devoted to original work on organic subjects. The *Journal* of the London Chemical Society is equally voluminous, besides which numerous *Annalen* and *Annales* are to be consulted, as well as all the year books in different languages, so that access to a large scientific library is absolutely essential, and several months may be consumed in this preliminary work, but it will be time well spent.

That organic research is attended with considerable expense will be evident If the raw material is cheap, or is a waste product, as is often the case, it must be put through a great number of operations before anything new can come out of it. The inhabitant of an old and densely populated country must travel far before he can commence the exploration of any unknown wilderness, passing over many miles of well beaten roads. So each successive investigator has farther to travel than his predecessors before he can reach an untrodden field. The way is long and the materials used must in most cases either be imported or prepared by the chemist himself. Occasionally some one, more fortunate than the rest, discovers a little wilderness near at home where he can labor at small expense and with fair chances of success. As a rule, however, poor men do not succeed well in their investigations of the mysteries of organic chemistry But there will soon be work enough of a practical nature, in analytical and manufacturing laboratories, with fair salaries, let us hope, to occupy those chemists who, having less originality and genius for investigation, are less likely to succeed in that than in other departments.

THE ANTISEPTIC PROPERTIES OF CARBONIC ACID.

THE author concludes from his many and extensive extensive experiments that carbonic acid is an excellent agent for preventing beef from putrefying and preserving its flavor for some weeks. Mutton behaves differently, and after remaining for eight days only in carbonic acid it gives off a putrid odor. Veal is not protected nearly so well as beef.—*H. Kolbe, in Journ. für Praktische Chemie.*

ZINC ON SULPHUR.

HERR SCHWARZ describes (in *Berichte der Deut. Chem. Ges.*, xv., 2505) three lecture experiments illustrative of the action of zinc on sulphur: 2 parts of fine zinc powder are carefully mixed with 1 part of flowers of sulphur, and the mixture is ignited by an ordinary match; combination occurs with evolution of much light. Vapor of carbon disulphide is passed over zinc powder, which is gently heated in a piece of glass tubing; zinc sulphide is produced, and a considerable quantity of carbon is separated. Sulphureted hydrogen is passed through carbon disulphide, and the mixed gases are then conducted over hot zinc powder; zinc sulphide is produced, and a gas, which is passed through potash and collected in a small gas holder; this gas burns with a slightly luminous flame, and explodes when mixed with air; it is marsh gas.

TESTING FOR IODOFORM, NAPHTHOL, AND CHLOROFORM IN ANIMAL SUBSTANCES.

S. LUSTGARTEN contributes the following to the *Chemisches Centralblatt:*

Iodoform.—In the bottom of a short test tube place a very little alkaline phenol, consisting of two parts of carbolic acid and four parts of caustic soda to seven parts of water, and add from one to three drops of an alcoholic solution of iodoform. On warming carefully over a small flame, a red deposit will be formed on the bottom of the tube, which will dissolve in a few drops of dilute alcohol, with a carmine red color.

To test for iodoform in urine, some of the ethereal solution of iodoform was added to it, and then distilled in a current of steam until about 50 c. c. had gone over; the condenser was rinsed out, and caustic potash added to the neutral distillate, which was afterward shaken up with ether in a separating funnel. The ethereal solution, after separating, is allowed to evaporate to dryness spontaneously, and the residue dissolved in a few drops of alcohol, and this solution used in making the test. In this way it was possible to detect with certainty the presence of two or three milligrammes of iodoform in any amount of urine.

To detect iodoform in blood, caustic potash enough was added to render it alkaline, so as to prevent coagulation, and then distilled in steam, *i. e.*, by passing through the warmed liquid a current of steam which was afterward condensed by passing through a Liebig's condenser or other form of cooler. The distillate was treated as before, with this difference, that dilute sulphuric acid was added to the ethereal extract after separating it from the water, so as to combine with any amine bases that might have been carried over in the distillate.

Naphthol—If alpha or beta naphthol is dissolved in strong caustic potash, chloroform added, and then warmed to about 50° C (122° F.), a magnificent (Prussian) blue liquid is obtained, but the color is not permanent. A few tenths of a milligramme of naphthol dissolved in a drop or two of potash on a watch glass and gently warmed will give a distinctly blue color with one drop of chloroform.

In testing urine for naphthol, it must be acidified with hydrochloric acid and distilled. The distillate is taken up in ether, the latter evaporated, the residue dissolved in caustic potash, and the test made as above.

Chloroform.—It is evident that the mutual reaction of naphthol, alkali, and chloroform on each other in producing a blue color can be used in testing for chloroform by adding some naphthol.—*Chem. Zeit.*

THE CHEMICAL THEORY OF GUNPOWDER.

THE Bakerian Lecture delivered before the Royal Society this year was on the "Chemical Theory of Gunpowder." The lecturer, Professor Debus, F.R.S. of the Royal Naval University of Greenwich, and of Guy's Hospital, had devoted several years to the inquiry whether a formula expressing the combustion of gunpowder could be arrived at. Messrs. Noble and Abel have worked very much in the same line, and what he had to say was to a great extent a criticism of what they have written. He points out, *inter alia*, that to obtain the products of the combustion of gunpowder they fired powders in closed steel cylinders, and the residues, as a consequence, contained ferrous sulphide, and that by such removal of sulphur from the residue the numbers based on calculation derived from the products of combustion suffered Again, Noble and Abel analyzed the residues by the method of Bunsen and Schischkoff, which, as has been pointed out by Professor Debus, contains the error that potassium sulphide is converted in part into potassium hyposulphite, and, under certain conditions, into potassium sulphate. Hence, the fluctuations of Noble and Abel in the relative quantities of potassium sulphide, potassium sulphate, and potassium hyposulphite are partly, if not entirely, due to the method of analysis. Potassium hyposulphite decomposes at 225°, so that the potassium hyposulphite found in powder residues must be regarded as the product of the analytical method. The lecture is full of most interesting results, to the principal ones of which only we shall be able to refer:

(1.) The mean composition of Waltham Abbey powder can be expressed by the formula $16KNO_3+21{\cdot}18C+6{\cdot}68S$; and such powder when burnt in Noble and Abel's apparatus does so in accordance with the equation—

$$16KNO_3+21C+5S= 5K_2CO_3+K_2SO_4+2K_2S_2+13CO_2+3CO+8N_2 \ldots\ldots (1.)$$

The remainder, 1·68 atoms of sulphur, combined partly with the hydrogen of the carbon, partly with the iron of the apparatus.

(2.) The hunting and military powders contain for 16 molecules of saltpeter from 13 to 22 atoms of carbon, and from 6 to 8·4 atoms of sulphur.

(3.) A powder composed of saltpeter, pure carbon, and sulphur gives, on complete combustion, potassium carbonate, potassium sulphate, potassium disulphide, carbonic acid, carbonic oxide, and nitrogen, as products thereof.

(4.) By increasing the pressure during the combustion, *cæteris paribus*, the amount of carbonic oxide appears to decrease, and side by side with it an increase in the amount of potassium carbonate, of potassium disulphide, and of carbonic acid, while the yield of potassium sulphate is less. These variations in the products of combustion are, however, inconsiderable.

(5.) The burning of the powder consists of two different processes, the one following the other: (*a*) is a process of oxidation, during which potassium sulphate and carbonate, carbonic acid and nitrogen, and, perhaps, a portion of the carbonic oxide, but no potassium sulphide, are found; and (*b*) a process of reduction, where the carbon remaining free reacts on the potassium sulphate formed by the combustion, and the free sulphur reduces the potassium carbonate. The potassium disulphide is formed during this second stage of combustion.

(6.) The first stage of the combustion, the actual explosion of the powder, takes place in powders of very different composition according to the equation:

$$10KNO_3+8C+3S=2K_2CO_3+3K_2SO_4+6CO_2+5N_2. \ldots (2.)$$

As, however, it is probable that carbonic oxide is formed at the same time, it may, perhaps, be more truly represented by the equation:

$$16KNO_3+13C+5S= 3K_2CO_3+5K_2SO_4+9CO_2+CO+8N_2 \ldots\ldots (3.)$$

The constituents of the powder and of the products of combustion stand, according to equation (3), nearly in the same relation as in equation (2).

(7.) The ratio of the oxygen in the carbonate to that in the potassium sulphate and the carbonic acid is shown in equation (2) to be the simplest oxygen ratio, which by the combustion of a mixture of saltpeter, carbon, and sulphur to potassium sulphate and carbonate, carbonic acid and nitrogen can be formed. In other words, the equation (3) represents the simplest distribution possible of the oxygen of the decomposed saltpeter among the products of combustion. As now the molecular relation of the products of combustion in equation (4) lies very near those of equation (3), it follows that the oxygen ratios of the products of combustion in equation (3) represents the simplest case possible.

(8.) If the combustion follows equation (3) without, in short, any formation of potassium sulphide, the development of heat is the greatest possible which a mixture of the three constituents can bring about, the heat of formation of carbonic acid, potassium sulphate, and potassium carbonate stand in the simplest relation to each other. The relation of the heat of formation is:

$$3K_2CO_3 : 5K_2SO_4 : 9CO_2 = 1 : 2{\cdot}05 : 1{\cdot}04.$$

(9.) The sorts of powder in general use contain, however, more carbon and sulphur than is required by equation (3). This surplus of carbon and sulphur remains over at the end of the first stage. The carbon acts on the potassium sulphate as follows:

$$4K_2SO_4+7C=2K_2CO_3+2K_2S_2+5CO_2 \ldots\ldots (4.)$$

and the sulphur on the potassium carbonate:

$$4K_2CO_3+7S=K_2SO_4+3K_2S_2+4CO_2 \ldots\ldots (5.)$$

and they collectively form the second stage of the burning of the powder; they are endothermic, heat is not evolved, but rendered latent; they are not of an explosive nature, and in practice are probably seldom complete. During the second stage of the combustion the temperature of the products of explosion is diminished and the volume of the gas is increased.

(10.) If x, y, and z be positive numbers, and a represent how many molecules of carbonic oxide are formed by the complete combustion of a weight of powder containing x molecules of saltpeter, y atoms of carbon, and z atoms of sulphur, we have:

$$x\,KNO_3+y\,C+z\,S= \begin{cases} \frac{1}{28}\left[4x+8y-16z-4a\right] & (K_2CO_3) \\ +\frac{1}{28}\left[20x-16y+4z+8a\right] & (K_2SO_4) \\ +\frac{1}{28}\left[-10x+8y+12z-4a\right] & (K_2S_2) \\ +\frac{1}{28}\left[-4x+20y+16z-24a\right] & (CO_2) \\ +a\,CO \\ +\frac{1}{2}xN_2. & \end{cases} \quad (6.)$$

(11.) On the assumption that $x = 16$ and $a = 0$, the volume of the gases evolved by the combustion is arrived at by the equation:

$$V=\frac{160+20y+16z}{14} \ldots\ldots (7.)$$

and the units of heat:

$$W = 1000\,[1827{\cdot}154 - 16\,925y - 8{\cdot}788z] \ldots\ldots (8.)$$

With an increase of y and z the amount of gas increases, while the amount of heat decreases, and *vice versa*. A mixture of

$$16KNO_3+8C+8S$$

gives of all possible mixtures containing 16 molecules of saltpeter, and which yields K_2CO_3, K_2SO_4, K_2S_2, CO_2, and N_2, or three or four of these products, the greatest amount of heat and the smallest quantity of gas, while a mixture of the form:

$$16KNO_3+24C+16S$$

yields the largest amount of gas and the smallest quantity of heat.

(12.) The product of the quantities of gas and of heat may be used as a measure of the power of doing work of different kinds of powder. This portion of the lecture requires a diagram to illustrate it.

(13.) From the results just referred to, it becomes possible to arrive theoretically at the composition of a mixture of powder which shall satisfy certain definite requirements. In comparing equal weights of different powders, it follows that an increase of sulphur above 8 atoms to 16 molecules of saltpeter and 16 to 24 atoms of carbon leads to no, or at the most to no considerable increase in the power of doing work of the mixture formed. A powder with 8 atoms of sulphur can, as inspection of the geometrical construction of the coefficients of the equation referred to above shows, not contain more than 22 atoms of carbon; a mixture, therefore, which contains 16 molecules of saltpeter, 22 atoms of carbon, and 8 atoms of sulphur puts forth as much force as one consisting of $16KNO_3+24C+16S$. If, therefore, we set ourselves the task of forming a powder which with the least possible amount of carbon and sulphur shall be able to do the greatest amount of work, it would be a mixture of the form:

$$16KNO_3+22C+8S.$$

The military powders of most nations have the composition:

$$16KNO_3+21{\cdot}2C+6{\cdot}6S,$$

or a ratio which lies very near that required by theory.

(14.) But powder does not contain pure carbon, but hydrogen and oxygen as well in the charcoal. The oxygen is partly evolved as water in combination with some of the hydrogen; the rest of the hydrogen causes the formation of ammonia, marsh gas, and hydrogen sulphide, or sulphureted hydrogen. These by-products, which form only from 1 to 2 per cent. of the burned powder, and stand in no direct relation to the explosion, may consequently be disregarded.

(15.) Powders containing an excess of carbon burn more slowly. The oxygen of the carbon is not separated as water, but in combination with carbon as carbonic acid or carbonic oxide. A specimen of Curtis and Harvey's powder burned in the apparatus of Noble and Abel in accordance with the equation:

$$4KNO_3+7C+2S=K_2CO_3+K_2S_2+3CO_2+3CO+2N_2,$$

or with the oxygen divided thus:

$$K_2CO_3 . 3CO : 3CO_2 = 3 : 3 : 6.$$

NAPHTHALIN AS A WOUND-DRESSING.

By G. R. FOWLER, M.D.

A LARGER experience in the use of antiseptics in the treatment of wounds has brought conviction to the minds of many who have been slow to acknowledge their usefulness. The opponents of asepsis and antiseptics, who have been sneered either openly at those whom they assert to be frightened into bringing the most deadly weapons to bear upon enemies scarcely discoverable with the aid of the microscope, or have "damned with faint praise" the use of agents aseptic and antiseptic, have gradually grown less and less in number, until to day there are very few, if any, surgeons who do not in some way or another seek to obtain immunity from disaster in wound treatment by the systematic employment of some antiseptic agent.

That the fear entertained by some of the dangers arising from exposing large surfaces to the action of carbolic acid were not unfounded, has been proved by the now numerously reported cases of carbolic intoxication on record; hence, investigators have turned their attention to seeking out some equally reliable yet safe antiseptic. Iodoform, received with general favor at first, has suffered a check, and its field of usefulness has been circumscribed, to a considerable extent, by reported cases of its fatal effects. Its use has been forbidden, on the ground of its dangerous effects, in at least one surgical clinic* in Germany, and a reaction has set in against it in some quarters, in strange contrast to the enthusiasm that heralded its introduction as a wound-dressing. This has risen, in great measure, from its indiscriminate employment in unnecessarily large quantities. Extensive wound cavities have been filled with it, and it would appear to have been the boast of some operators that their patients could bear large quantities of the drug in their joint cavities, rather than an endeavor to demonstrate how small a portion could be made available, yet efficient. During the late war in Egypt, the English surgeons found that the most reliable provisional, as well as permanent, dressing, consisted in the dusting of the parts with iodoform, after thorough irrigation with a 2½ per cent. solution of carbolic acid, or the application of a solution of chloride of zinc, and subsequent dressing by means of a strip of oil-silk, or what is known as "Lister's protective," and a few layers of gauze or bonted lint or cotton. The oil-silk was not used as a protective to shield the wound from any noxious effects of the iodoform, inasmuch as the latter was applied next to the wound itself, but simply as a ready means of keeping the dressings from adhering to the wound when it became necessary to redress the parts.

Carbolic acid will probably continue to hold its place, from its readiness of application as a means of irrigating wounds which have been exposed to septic influences; and, with the merits of chloride of zinc more fully appreciated, it will be found that scarcely anything else will be needed for that purpose. But there are occasions where large wounds must necessarily be left to granulate—for instance, those made by operations through the vagina, as well as those within the rectum and oral cavity, and the cavities remaining after extirpation of masses of infiltrated and suppurating lymphatic glands, etc.; it is here that is particularly needed some efficient, yet safe, antiseptic; and it is in these cases that carbolic acid is difficult of application, and in which both it and iodoform have been condemned as unsafe.

As the germ theory of the origin of the sequelæ of wounds becomes more fully recognized as an accomplished fact in surgical practice, increasing demands are made by the scientific investigator upon nature and the chemical laboratory for the production of agents capable of destroying the life of or nullifying the evils arising from the presence of specific germs in the organism, without doing injury to the individual. The most recent, as well as the most promising addition to our means of combating sepsis in all its varied forms in wound treatment is that which has been brought forward by Lücke, of Strassburg. The agent proposed by Lucke is naphthalin, a product of the distillation of coal-tar, and it is to the claims of this article as an antiseptic in the treatment of wounds that attention is now invited.

Naphthalin in a pure state is a white substance, occurring in laminated crystals; its formula is given in works upon chemistry as $C_{10}H_8$. It forms wherever organic bodies, especially those containing an abundance of water, are burned. Coal-tar contains it in large quantities, and it is obtained by subjecting this substance to distillation. It passes over after the coal-oils, and it is produced by passing the vapor of coal-tar through red-hot tubes. It is derived from the residue of gas manufactories, and not unfrequently clogs up our gas-pipes. In its crude state it is a brownish yellow, sand-like substance, containing an indefinite quantity of the phenols. It may be purified by sublimation with charcoal, and, as before stated, when in a pure state is a white crystalline body. It has an odor decidedly like that of coal-tar, and a slightly aromatic taste; its specific gravity is 1·05; it is volatile at any temperature, but melts at about 176° Fahr., and crystallizes upon cooling; it boils as 420° Fahr. It is inflammable, and burns with a lurid, smoky flame. It is but sparingly soluble in water and in the secretions of wounds, but its gaseous vapor is given off readily at the temperature of the body, and especially when in contact with moist surfaces; it is likewise insoluble in alkaline and acid fluids; it is readily dissolved by ether, hot alcohol, hot concentrated sulphuric acid, and the different ethereal and fatty oils. It is deposited from its alcoholic solution in white lamellar iridescent crystals. In the sulphuric acid solution a sulpho-naphthalic acid is formed. Naphthalin combines with chlorine, producing two chlorides; these latter, upon further investigation, may prove serviceable and available as germicides. When exposed to a temperature of 310° Fahr., naphthalin sublimes quite rapidly in thin scales, and the atmosphere of a room can be thoroughly saturated with it in a gaseous state by simply adding some of the crystals to water and heating it. If the latter be continued for some time, naphthalin will be precipitated upon the walls of the apartment. If crystals of naphthalin are simply strewn upon the floor, the same result will take place, only more slowly. Nearly all of the samples obtainable contain more or less of the phenols as an impurity. The following test for pure naphthalin has been suggested by Dr. Schulte, of Strassburg: Dissolve a small quantity of naphthalin in a weak solution of chloride of sodium; heat to a boiling point—cool, and filter. If the filtrate is made slightly acid and a watery solution of bromine is added, phenol being present in small quantities, a milky condition of the fluid appears; if present in larger quantities, a more dense white precipitate, the bromide of phenol, is formed.

Naphthalin produces no poisonous effects upon man and the higher animals when given internally or applied to large absorbing surfaces, but it is most efficiently destructive of low vegetable and animal organisms, such as fungi, spores, small insects etc. The preservation of meats, after exposure to smoke, is partially due to the influence of this body. It, therefore, belongs to the class of germicides, and bids fair to prove of value as an aseptic and antiseptic in the treatment of wounds.

In my own experience with naphthalin I have noticed that when it is used in an aseptic manner, that is to say, when it is brought in contact with fresh wounds that have never been in a septic condition, they continue in an aseptic, and consequently in a healthy state; and that septic and unhealthy wounds, indolent ulcers, ulcerating cancerous growths, phagedenic chancres, etc., rapidly assume a healthy appearance when its antiseptic action is brought to bear upon them. This is due, without doubt, in the first place to an efficient protection of the wound from septic influences, and in the latter instances to a complete and thorough disinfection of the wound. Its application does not interfere with free drainage from wound surfaces; in a powdered state it may be applied directly to the cavity, or over the parts, after suturing the edges. Serum and blood will percolate through it precisely as they would through sand. As an additional advantage, it does not unite with wound secretions to form crusts or scabs.

I have found, as a simple and convenient method of employing naphthalin, that of using it in substance, finely powdered. After thoroughly disinfecting the wound—if it is not already aseptic—and surrounding parts with a solution of carbolic acid or chloride of zinc, suturing and making proper provision for drainage, I cover the parts to be dressed with a narrow strip of oil-silk previously dipped in a 1 to 40 solution of carbolic acid, and perforated here and there to facilitate the egress of whatever secretions may accumulate beneath it, as well as to permit the vapor of the naphthalin to penetrate to the wound itself. This also serves the purpose of preventing the dressings from adhering upon removal. I then make a roll of absorbent cotton about half an inch in diameter, and in length sufficient to inclose the wound and an inch or more of the contiguous parts; this is wrung out of the solution of carbolic acid or chloride of zinc, and disposed as a ring encircling the wound and adjacent surface. Within the space thus isolated, I sprinkle the naphthalin in a powdered state to the depth of a quarter of an inch or more, place a dressing of absorbent cotton over it, and apply a muslin roller over all. This dressing is not disturbed until the wound secretions make their appearance through and soil the bandages, or some other indications exist for their removal. In a recent case of Hueter's operation for resection of the head of the first metatarsal bone for hallux valgus, the dressings were first removed at the end of eight days. The parts were in a typically aseptic condition, and only the odor of naphthalin gas pervaded the dressings. In the case of cavities left after operations for the removal of suppurating buboes, necrosed bone, etc., simply packing the cavity in all of its recesses, after thorough disinfection, and applying a dressing of absorbent cotton, is found to be sufficient. After operations within the vagina and other natural cavities having outlets, absorbent cotton, in the meshes of which naphthalin has been incorporated, either by saturating it with its ethereal solution and subsequently drying, or simply by rubbing in the powder, may be used. Dressing materials, gauze, etc., may be especially prepared in the same manner as like dressings are prepared containing carbolic acid and iodoform.* The method above described possesses the merit of simplicity, however; as to its efficiency, I can bear testimony with great positiveness.

As to the possibility of any dangerous symptoms arising from its free use, I can only say that Lucke and Fischer, of Strassburg, have used it largely, and no disturbances of any kind whatsoever have followed its use. In my clinic at the Bushwick and East Brooklyn Dispensary I have now employed it in a large number of cases, in both young and old, feeble and strong; filling large cavities and applying it unsparingly, I have always met with the best results following its use, and never with a single untoward sequence. I have found it convenient of employment; its odor is not more objectionable than that of carbolic acid, and certainly not as disagreeable to the average nostril, nor as difficult to get rid of as that of iodoform.

Its price ranges, according to its purity, from twenty to eighty cents a pound. I have succeeded in procuring a fairly pure article from Lehn & Fink, of New York, at the latter price; I have no doubt, as it comes into more common use, it can be obtained at a much lower price. The cheaper varieties are sufficiently pure for sprinkling about the floors of hospital wards, water-closets, etc. As a dressing for wounds it certainly is cheaper than any other efficient antiseptic thus far discovered.—*Proc. Med. Soc., Kings Co.*

* Prof. König, of Göttingen.

* The enterprising firm of Seabury & Johnson, of New York, have in preparation for me antiseptic gauze and antiseptic absorbent cotton, impregnated with naphthalin.

UNCONSCIOUS BRAIN-WORK.

WORDSWORTH has testified that his best poetry was created by allowing his mind to direct itself intently upon all the phases of his subject, and then waiting for a spontaneous outflow of poetical imagery from his mental mechanism. Mozart, whose musical faculty had from childhood been trained with most assiduous care, had only to think out the general plan of a composition, deciding as to the place to be given to solo, recitation, duet, quartet, and then allow his thought to work of itself and envolve its own results. In the same way trained mathematicans solve difficult problems. But most instructive of all is the action of memory. We endeavor to recall some half-forgotten fact, name, or date. After fixing the attention upon the subject for a certain length of time, and recalling every accessible circumstance, we find it better to withdraw the attention, to "hang up" the subject, and leave the matter to time. The general result will be a sudden return of the missing fact to the consciousness. In all these cases of "unconscious cerebration," it is noteworthy that we must first give direction to the process, and, moreover, that in order to obtain results we must previously train the automata.—*Lectures by Dr. Carpenter.*

SASSAFRAS IN RHUS POISONING.

DR. HINTON advises *sassafras root in poisoning by Rhus toxicodendron*. He has used it upon himself, and in the cases of a great many patients, and prefers it to all other remedies. A strong infusion is made of red sassafras root, allowed to cool, and then applied frequently by means of cloths wet in it. Recovery may be expected within twenty-four hours. —*N. Y. Med. Journal.*

PASTEUR ON HYDROPHOBIA.

IT is gratifying to know that M. Pasteur, with his remarkable powers of research, is at present engaged in the study of hydrophobia. The results of his recent observations (made in concert with three other physiologists) have just been communicated to the Paris Academy. *Inter alia*, it is found that all the forms of rabies proceed from the same virus, and one may pass experimentally from one form to another. The character probably depends on where in the nervous system the virus is localized. In the saliva the virus is associated with various microbes or small organisms, and inoculation with the liquid may cause three kinds of death, that from the microbe, that from large production of pus, and that by rabies. The *medulla oblongata* (or link between the brain and spinal cord) in a person that has died of rabies is always virulent, and the virus is also found throughout or in a part of the brain, and (of equal strength) in the spinal cord. The virulence persists so long as putrefaction has not set in. Rabies may be developed surely and quickly either by trepanation and inoculating the surface of the brain, or by injection into the veins; the disease manifests itself in six, eight, or ten days. Rabies produced by intravenous injection is often very different in character from that given by bite or trepanation. In intravenous inoculation the spinal cord seems to be first attacked. Inoculation with rabid saliva or blood, by intravenous injection, where not proving fatal, does not necessarily preserve from rabies and death after a fresh inoculation of pure rabid matter. Spontaneous cure of rabies sometimes occurred after only the first rabid symptoms were developed; never after the acute symptoms appeared. Sometimes, long after the date of disappearance of the first symptoms (two months) acute symptoms occurred, and were followed by death. M. Pasteur now has four dogs which cannot take rabies, however inoculated and whatever the strength of the matter. He is at present unable to say whether they are preserved by having had the disease mildly and recovered, or by being naturally refractory (if that be a possible case). In the course of this investigation inoculations to the extent of more than 200 were performed on dogs, rabbits, and sheep.—*London Times.*

THE REMOVAL OF FIXED GLASS STOPPERS.*

WHEN the glass stopper of a bottle is ground fine enough to prevent leakage and is well put into its seat, it is generally somewhat difficult to get out. Often it is impossible to remove it by the ordinary means of tapping it and unscrewing with the fingers, and then most persons sacrifice the bottle by breaking off the neck. A glass stoppered bottle that is so well ground as not to require the slovenly use of grease, or other aids to bad work, involves a good deal of skilled labor, and it is a real waste to destroy it, even if this can be done without any loss of the contents in breaking it.

It is a fact not generally known that the very finest and most skillful stoppering that is practicable on a large scale and at moderate cost is not entirely effective against loss of many volatile liquids. A tray of fifty one-pound bottles of ether, kept in a cool cellar and carefully weighed from time to time, lost at the rate of more than an ounce a month throughout the whole experiment, although stoppered as well as practicable, and never agitated. When agitated, as by transportation, and especially when transported in warm weather, the loss must be many times greater, and accidental imperfection in stoppering, or in the exposure of a box of bottles to a summer sun in long transportations, will occasionally cause the loss of a considerable part, or even the entire contents of some bottles, so that they reach their destination partly or entirely empty, but with little or no sign of leakage perceptible, so that the bottles look as though they had been put up partly full or empty. And leaks so small as not to be discoverable when put up, are quite sufficient to empty a bottle during transportation.

These difficulties are greatest with such liquids as chloroform, ether, and nitrite of amyl, and the latter is the most difficult of all. All these stoppers require to be put in as tightly as it is possible to put them in, and all stoppers are screwed in with what is called a stopper wrench, and such a wrench is needed to take them out. This is a piece of hard wood about 3½ inches long by about 1 or 1¼ inches in breadth and depth. In the middle of one side a mortise is cut nearly through, just long enough and wide enough to admit the flat part of the largest size stopper. This is applied to the stopper gives a very considerable leverage, and with it stoppers are screwed in by turning them in the direction of the movement of the hands of a watch, as all right hand screws are put in. To take the stopper out it must, of course, be unscrewed or turned in the opposite direction. In this way almost all stoppers may be taken out safely if the neck of the stopper be strong enough to bear the strain, especially if the stopper be smartly tapped, first on one side and then on the other, by the wooden wrench before it is applied to unscrew it. But some liquids have a tendency to cement the stoppers into their seats either by drying in the joint or by a slight action upon the glass surfaces. Such liquids as solutions of soda and potassa, and especially the disinfectant solution of chlorinated soda, almost always render the stoppers immovable by any ordinary means, and even the stopper wrench will often fail to start them. It is highly probable that half the bottles used with such liquids are sacrificed before the contents can be got at, and in breaking off the necks the break often extends so that a part of the contents is liable to be lost.

When a stopper resists all management—by warming the neck with a cloth wet with hot water, by tapping, and by the wrench, or by all these in combination—there is another means which will almost always succeed. Let the bottle be inverted so as to stand on the stopper in a vessel of water, so filled that the water reaches up to the shoulder of the bottle, but not up to the label. The vessel should be so large that the bottle stands in an inclined position, or otherwise a portion of air may be trapped in the gutter between the mouth of the bottle and the stopper, and thus prevent the access of the water to the joint which is to be soaked out. The bottle should stand in this position over night, and if still refractory, for another day and night, and if still tight, three or more days, and in such cases the water should be warm at first and again quite hot for the last five minutes before the wrench is applied. There are many bottles which are very valuable, and the better the stoppering the more valuable they are. Almost all such may be saved by the means indicated, if the necessary time and patience be given.

Many bottles which are hardest to unstopper by reason of the action of the liquids on the glass are unfit for any after use, and might about as well be sacrificed as not, were it not for the liability of losing the contents in breaking them.

* From an "Ephemeris of Materia Medica, Pharmacy, Therapeutics, and Collateral Information," by Edward R. Squibb, M.D., Edward H. Squibb, S.B., M.R., and Charles F. Squibb, A.B. Brooklyn N. Y., November, 1882.

THE BRAIN-WEIGHT OF GAMBETTA.

THE report brought by cable that the brain of Gambetta, when examined by the experts, was found to weigh 1,100 grammes, or less than 39 ounces, gives, says the New York *World*, a curious interest to the general subject of head measurements, and especially of brain-weights. "The brain of the adult human male," we are told, "comprising the whole contents of the cranium as far as the occipital foramen, will average in weight about 50 ounces, and that of the adult female about 45. The maximum weight of the healthy brain is about 64 ounces and the minimum about 31. In cases of idiocy it has been found weighing only 20 ounces." "In men," according to the commonly received authority, "there is no fixed relation between the size of the body and that of the brain—a small man may have a large brain and *vice versa*. Men of great intellectual power have generally, if not always, possessed large brains, though the quality of the brain is quite as important as the quantity." Broca places the lowest limit of brain weight compatible with human intelligence at 30 ounces in males and 32 in females, the average weight of the European male brain being 49 ounces. Dr. Bischoff, of Bonn, published two or three years ago perhaps the most exhaustive study of the subject ever undertaken. He had examined and weighed the brains of 559 men and 347 women. His figures were as follows:

	Highest. Grammes.	Oz.	Lowest. Grammes.	Oz.	Average. Grammes.	Oz.
Male	1,925	67·9	1,018	35·9	1,362	48
Female	1,565	55·2	830	28·9	1,219	43

In this table the hectogramme of 100 grammes is taken at 3·5274 ounces. Bischoff weighed the brains of ten cultivated and celebrated men, some of which he found below the average, while none reached the maximum. The brains of sixteen murderers averaged 90 grammes less than the ordinary brain, while not one attained the common size, but his other researches did not tend to establish the theory that there is such a type as the "criminal brain," as the brains of 119 ordinary offenders weighed 11 grammes more than the average, some having a weight of 1,500 and even 1,600 grammes. In regard to the insane, his researches showed that, with the exception of idiots, they usually have brains of the average weight. In the fact that the female cerebrum is smaller than the male, Professor Bischoff affects to discover the reason of the alleged comparative inability of women to deal properly with philosophical and scientific questions. Delaunay, it may be said, in his elaborate treatise in support of the thesis that woman is intellectually, as in every other respect, inferior to man, dwells on the same subject. Broca puts the brain-weight of the male and female sexes respectively at 111 to 100, and Huschke estimates the mean capacity of the cranium for Europeans at 1,446 cubic centimeters in man and 1,226 in woman. Le Bon, who places the average of the modern Parisian head at 1 550 cubic centimeters, has gauged all the skulls in the Gall collection of the French Museum of Natural History, the following being the capacity of the heads of several well-known historical characters:

Spurzheim and La Fontaine	1,950
Volta, the electrician	1,850
Thouvenin, manufacturer and inventor	1,825
Abbe Gautier, author of school-books	1,779
Cassaigne, jurisconsult	1,755
Jean sans Peur, Duke of Burgundy	1,750
Marshal Jourdan, and David, mathematician	1,725
De Zach mathematician	1,715
Careme, the cook; Chinevin, the chemist; and Descartes	1,700
Gall	1,693
Boileau	1,690
Unterber, artist and mechanician	1,660
Juvenal des Ursins, Chancellor of France	1,525
Wurmser, the Austrian General	1,510
Axtinger, poet	1,505
Bishop Roquelaure de Bessuyole	1,365

Broca, on comparing 115 skulls taken from a vault closed up not later than the twelfth century with another series of 125 skulls taken from a cemetery belonging to the earlier years of the present century, found the average capacity to be 1,426 and 1,462, showing a considerable gain during seven centuries of progressive civilization. This fact may be set against the recent newspaper articles, inspired by Mr. Tuckett's paper in *Nature*, in which it has been contended that the average human head has been gradually diminishing in size, the statistics depended upon being obtained from the hat trade, to say nothing of the simpler solution afforded by the fact that half a century ago hats were worn much further down upon the head than at present, not to mention the differences between a wigged and a wigless age. More important is Mr. W. B. Cooper's theory that in the higher grades of modern civilization the human skull is becoming thinner.

As to the actual weight of the brains of eminent men, full statistics are not obtainable. Generally speaking, among uneducated people the proportion of brain-weights above 55 ounces is from 4 to 6 per cent., while among men distinguished for great intellectual acquirements it is at least 23 per cent. Taking individual cases, some twenty-three in number, Cuvier, the naturalist, heads the list, according to one authority, with 64½ ounces, and, according to another, with 64·33. Appletons' Encyclopedia gives him "between 59 and 60." The brains of Abercromby, the physician, and of Schiller, the poet, weighed 63 ounces; then come Goodsir, the anatomist, with 57½; Sir James Simpson with 54, and Chalmers with 53. Appleton says that the brain of Dupuytren, the great French surgeon, weighed 58 ounces, and the brains of Napoleon and Daniel Webster an ounce or two less. The brain of a mulatto who died not long ago at Cincinnati was found to weigh 61 ounces. He had been a slave, and was not considered bright intellectually. Dr. Peacock, examining 157 brain-weights of adult Scotchmen, found that four, all the brains of artisans, who, so far as could be learned, had not been distinguished above their fellows in their intellectual endowments, weighed over 60 ounces, while the heaviest brain on record, which weighed 67 ounces, according to Dr. Morris, was that of a bricklayer who "had a good memory and was fond of politics, but could neither read nor write, so that, whatever his potentialities, his actual acquirements were not great." It may surprise our readers to learn that the only statistics of Chinese brain-weights available show them to exceed all other nations in this respect, possibly because Chinese culture, if not of the most advanced kind relatively, has been longer pursued and pushed than any other. "A few years ago," we read, "the brain-weights of eleven adult male and of five female Chinese—the chance victims of a great typhoon at Hong Kong—were obtained. These belonged, with one exception, to the cooly or lowest grade of Chinese society, yet the average brain-weight of the males reached 50½ ounces, and that of the females 45½ ounces. This is an average not attained, so far as yet known, by any other nation, it being fully 6 ounces above that of the average negro, and 1½ ounces above the European." By way of completing these notes it may be said that the brain of Guiteau, one of the most phenomenal criminals, and certainly not one of the most admirable intellects of modern times, weighed 49½ ounces, exceeding by more than ten ounces the reported weight of the brain of the great French republican.

THE THREE-HEADED WOMAN.

IN the booths of the market fairs at Paris and its suburbs (for example, at the "Gingerbread" Fair, at the Fete of Saint Cloud, etc.), and in the tricks of jugglers, etc., who operate in the street, café concerts, or circuses, we find phenomena that have a true scientific interest, ingenious applications of different sciences, or simply tricks that puzzle the spectator. Since, in general, people like to know the secret of what has surprised them, it may not prove uninteresting to devote a few articles to what may be called "side-show science." At present, we shall speak of the process employed to produce the "three-headed woman."

FIG. 2.—FIGURE EXPLANATORY OF THE EXPERIMENT.

The exterior of the little booth in which this phenomenon is exhibited is covered by a large painted canvas representing a three-headed woman in evening costume in a richly decorated drawing-room along with a few persons. For better convincing the curious, a photograph taken from nature exhibits the phenomenal woman as she appears in the show; and every now and then the showman stops his drum to cry, "She is living, ladies and gentlemen, she is living!" If we allow ourselves to be persuaded to enter the booth, we shall find ourselves separated from the stage by a balustrade—a sort of screen, behind which is seen the curtain. In a few moments the latter separates and there is distinctly seen a woman's body, the lower part of which is hidden by a basket of flowers. This body has three heads; one in the middle and two others grafted at the base of the neck of the first. These three heads move their eyes, answer together a few questions put by the showman, stick out their tongues, sing a few snatches of a popular song, and finally salute the audience, when the curtain closes and the show is over.

On almost every occasion some ingenuous person is heard to express pity for this unfortunate person, who has no legs and three heads. This is the best praise that could be bestowed on the trick—for naturally it is only a trick. Moreover, the showman is ready, for money, to explain how it is done. If we allow ourselves to be tempted, and enter the side-scene, we perceive on the little stage where the phenomenal woman just appeared nothing but a large plate of glass, slightly inclined toward the audience, and its edges hidden by drapery. Behind the mirror there is a recess whose sides are covered with a dead-black fabric. In front of the mirror, on the stage, sits the basket of flowers from which issued the woman's body. Then, on an inclined board a little above the ground, lie three young girls. One of these, the middle one, is clothed in a brilliant costume of silk of a light color, and it is she who, in the exhibition, makes the trunk, arms, and the middle head. Her legs are covered over with a black fabric, and she is supported by a cushion so as to permit the two other girls to place their necks closely against hers. The bodies of these two girls at the sides are completely covered with a fabric of a dead-black color. In front of these three young women are placed a dozen strong kerosene lamps provided with reflectors (Fig. 2).

The heads, hair, and arms of the "body" are covered with powder so as to present completely white surfaces. Such is the secret as revealed from the side-scene, and it will now be understood how the phenomenon is produced. All the white or light colored surfaces being strongly lighted by the lamps that reflect the light, their image is sent by the glass toward the spectators, who perceive, then, the body of the female, her two arms, and her three heads. All the portions covered with black are, on the contrary, absolutely invisible in the glass, and the spectators cannot see that they exist. The phenomenon is, on the whole, a curious application of the effects of reflection which were in fashion some twenty years ago under the name of "living ghosts," and by means of which it was possible in theaters to cause the apparition, alongside of living persons, either of undecided forms or of bodies not resting on the ground.

The "Gingerbread Fair" this year showed a two-headed woman produced by a slightly different process, the body and head of the woman being seen directly, and the second head alone being seen by reflection from a glass. This phenomenon may be varied to infinity, so to speak. To cite only a few examples, there may be produced by the same process a decapitated person who talks; a decapitated person who holds his head in his hand, and a Judith and Holofernes, the head of the latter being held by the hair by the former.—*La Nature.*

FIG. 1.—THE THREE-HEADED WOMAN.

SPEECH IN ANIMALS.

THE languages in which animals converse more or less definitely with other individuals of their own, or of nearly allied, species were discussed in the *Journal of Science* some years ago (1875, p. 68). The conclusion reached was unfavorable to the common egoistic notion that speech is the exclusive prerogative of man. That conclusion we are still free to uphold. We regret, however, that, so far as we are aware, no one has undertaken a formal study of these animal tongues, so as to converse with any of our "poor relations" in their own language.

Commending this subject to the attention of such persons as have the needful time and the opportunities at their command, we wish now to examine the attempts of certain of the lower animals to acquire human speech.

It seems at first sight curious that these attempts have been made with the greatest success, not by the mammalian groups which rank physiologically and psychologically nearest to us—such as the apes and the Carnivora—but by certain birds. But we must remember that a number of attributes must coexist in any animal before it can be capable of speech. In the first place, its vocal organs—especially the tongue, the glottis, and the pharynx—must be constructed in a manner equivalent to, if not identical with, the same parts in man. Secondly, there must be a sufficient degree of general intelligence. The animal must be capable of remembering sounds, of perceiving the differences between them, and of connecting them with objects, events, wants, etc. In addition there must be an especial development of those parts of the brain which control and regulate the action of the vocal organs. This development, it is scarcely needful to say, is most likely to be met with among gregarious species which require and possess a tolerably complete language of their own.

But there is still a further condition: an animal before it can be expected to learn human speech must be brought into close and friendly intercourse with man. The impossibility, or at least the difficulty, of such intercourse, especially in those countries where experiments of this kind have been generally attempted, is a most serious obstacle. Another kindred drawback is that many of the most promising animals do not—in Europe, at least—breed in captivity, and are thus withdrawn from hereditary influence and from a selective development carried on through a number of generations.

As regards the birds which have hitherto acquired some knowledge and command of human speech, there prevails a difference of opinion. The question arises, do they understand the sounds they remember and repeat, and use them with a due regard to their meaning; or do they reproduce words in the same manner as does a human mimic when imitating the squeak of a pig or the quack of a duck, without any knowledge of or care for signification? The latter is the current opinion. It is maintained that every appropriate, and especially every witty thing said by a parrot is a mere coincidence. But this view admits of an easy and complete refutation. We ask: Is the bird in the habit of repeating the happy phrases which figure in popular anecdotes, in season and out of season? If so, we might admit that "Polly" speaks merely by rote, and without understanding. But there is good evidence to show that parrots can and do connect their utterances with certain objects, events, times, and other circumstances, and do not therefore speak simply at random. Of this the following cases, for which we can personally vouch, will serve as proof: A parrot, whenever she saw any food being prepared or consumed, invariably cried, "Give Polly a bit, if you please!"—an exclamation which she was never known to utter on any other occasion. Another was accustomed to have her cage covered over with a shawl at roosting time, in order to shut out the gaslight: if this was forgotten, the parrot cried out very emphatically, "Polly wants to go to bed!" This speech she was never known to utter at any other time. A magpie, which belonged to a neighbor of ours at Stow-market, learned, without any instruction, the names of several members of the writer's family, rarely failing to utter them on sight of their bearers, but never pronounced them at any other time.

The following case, communicated by M. l'Abbé Gras to *Cosmos les Mondes* (Oct. 21, 1882, p. 297), refers to an African gray parrot which was at first very wild and timid, and which M. Gras has kept for four years in company with a green Brazilian parrot which was previously very tame, though less intelligent. He names the gray parrot Coco and the green one Cocotte. When being put back into the cage, Coco calls out: "We are going to the cage." If a supply of seeds is given her, she says, "Here is something good." When swinging, she cries, "Coco is swinging." If her companion screams, she says, "Come, Cocotte, don't scream; sing!" If Cocotte sings, Coco exclaims: "You sing well; oh, very well!" The two birds were walking in the dining-room, and Cocotte began to sing; Coco said, "Some one is singing." "When asked, "Who is singing?" she answered, "Cocotte." The latter bird on one occasion went under the sideboard, when Coco, looking down, cried, "What are you doing there, Cocotte?" M. Gras was giving some directions to his housekeeper, when Coco exclaimed: "How, don't you understand?" The worthy Abbé vouches for the exact truth of all the above facts, and adds that he has numerous witnesses who can corroborate what he asserts.

These and many other authentic cases which are on record, but which it is not necessary here to repeat, show that such birds attach a definite meaning to certain phrases, and use them just as do we human beings. The contention may still, however, be raised that such birds do not understand the individual words, but merely the phrase or sentence as a whole.

Supposing, however, that this is the case, we must admit that such is the precise manner in which human children acquire the knowledge and use of language. The child learns a phrase as a whole, connects it with the object or occasion to which it is appropriate, but does not for some time resolve it into its component parts and employ these in new combinations. But we have observed that intelligent parrots do occasionally vary their stock phrases by fitting in additional words or leaving out some of the old ones. Thus a parrot belonging to the present writer one day saluted a lady visitor with "Good morning, ducky!" a combination which the bird had never heard.

Another interesting point of comparison here appears between young children and parrots. Talking birds, as far as we are aware, never speak in the first person. The parrot, addressed as "Polly," speaks of itself as "Polly"—that word being the symbol for its own personality. But this holds good of young children also. The child always accosted as "Baby" speaks of itself as "Baby," using the third person instead of, as in after life, the first; or, in other words, the child uses its own name instead of "I" or "me."

There is yet a further similarity; a parrot, when trying to learn a new phrase, often blunders, especially about the last word or words. That of the present writer, above referred to, was lately studying the phrase, "Who's a rogue?" For a couple of days she repeated, "Who's a —— Who's a who—?" till at last the final word got fixed in her memory, and she ejaculated, "Who's a rogue?" with great emphasis. Something closely alike is traced in young children when learning to talk; they also bungle and break down over the latter portion of a phrase, and, when it is fully mastered, use it for a time both in and out of season.

Thus it would appear that, as far as the use of language is concerned, the intellect of an African gray parrot is on a level with that of a child about eighteen months of age.

We are often asked, in reference to this point, Why does the child continue to acquire greater powers of language, to retain a greater number of words, and to combine them as occasion requires, while the parrot soon comes to the close of its literary education? The answer, surely, is not far to seek; the child is descended from hundreds, perhaps thousands of generations of talking animals, and inherits the gradually accumulated aptitudes of its forefathers. Merely, however, let us remember, the aptitudes, for the child brought up apart from human society does not inherit articulate speech.

With the parrot the case is totally different; she inherits merely the tendency to scream and whistle, and, as far as language is concerned, she is a sheer parvenu who has risen by her own exertions, without any ancestral resources.

We know of no case of an African gray parrot (*Psittacus erythacus*) having reproduced its species in Europe.* Were this to be done, the young birds would doubtless be feeble and die out. But the experiment might be tried with this species, say at Madeira, or in some locality not too inimical to civilized man. Or it might be attempted in temperate South America with *Chrysotis amazonica*, which is said to be even more docile and intelligent than the African gray parrot. If a pair of clever parrots were matched, and the experiment were carried on for several generations with their offspring, always selecting the most docile and intelligent birds, there can be little doubt but that most interesting results would be reached. The adaptability of the vocal organs to articulate speech, the power of the brain to regulate and co-ordinate the action of the muscles of those parts, would assuredly undergo a gradual development. In like manner the memory for words and for their connection with the objects which they symbolize, would be strengthened. What ultimate end might thus be reached it is impossible to predict. Perhaps in these days of cram and of the equal rights of animals we may, in five centuries, have magpies in the "fifth and sixth standards," macaws preparing for the examination of the Science and Art Department, and cockatoos —"sweet *bird* graduates"—taking their degrees at the University of London.

(A cantankerous acquaintance who sometimes intrudes into our sanctum, looking over our shoulder, remarks that we have already reached all these results.)

In sober sadness we trust that such experiments will be carefully undertaken and carried on for the needful length of time. Of time, indeed, there must be no stint, for parrots arrive but very slowly at maturity.

So much, then, for birds. But how about talking mammalia? We can scarcely deny that the anthropoid apes, the dog, the cat, the elephant, are more intelligent than the parrots, ravens, magpies, starlings, etc. It is generally admitted that they understand our spoken language to a very considerable extent, even in matters where tone, gesture, or expression of feature throw no light at all upon our meaning. We know instances where words of reproach, though intentionally uttered in a mild tone, have been at once comprehended both by dogs and cats.

A very intelligent dog described by M. A. Roujon† will, when ordered by his master, fetch, without ever being mistaken, his pipe, tobacco, a knife, a fork, etc. When he hears merely the word "sport" (*chasse*), he rushes to his master's gun. This dog belongs to M. Antoine Barthomeuf, who keeps a café in the Place de l'Eglise, at Chamalières, near Clermont-Ferrand. But why, then, as mammalians so clearly understand and remember our language, are they so little capable of acquiring its use? We will admit that it is, for the majority of men, easier to understand a language than to speak it. But this well-known fact is far from explaining the difficulty. Does it lie in the different structure of the vocal organs? This difference in the higher apes is but trifling. In the Carnivora it is greater; their tongues are relatively longer and slenderer, and better adapted for lapping up liquids, or for licking and rasping the bones of their prey, than for going through the various evolutions within the mouth required for the production of articulate sounds. The voice of the cat is deficient in compass, and that of the dog too abrupt and jerky. The anthropoid apes, though given to converse among themselves with great volubility, have never been brought sufficiently long and closely under human influence: they have never been known to propagate in a domestic condition, and their lives in captivity in Europe or in the United States are short and sad, since they are soon attacked by disease. Hence the opportunities for teaching them to talk have been insufficient. We would suggest that the attempt should be made, say, at Calcutta, or Buitenzorg, in Java, with the mias or the chimpanzee, just as we have suggested above in case of the parrots. The difficulty would be how to give these animals the freedom necessary for their health and vigor, and yet to bring them in sufficiently close contact with their keepers. We should propose that the course of training should commence with pregnant females. The young should then be brought from infancy into the society of kind and intelligent keepers, who should teach them to speak, those which showed the greatest aptitude being selected as the parents of the next generation.

Meantime it must not be forgotten that there are some mammalia which have, in rare instances, been known to utter a few words. Among these is the common seal—a singularly docile, affectionate, and intelligent creature, which might well claim at the hands of man a better treatment than to be massacred for the sake of its fur.

There have been various anecdotes of talking dogs, but the only instance which is duly authenticated is that of the dog of Clermont-Ferrand, above mentioned. This dog, a setter, can, according to M. Roujon, utter the words "*ma maman*." "To make the dog speak," says this author, "it is necessary to stand before him and bid him pronounce the words *ma maman*, showing him some bread or meat. The dog then becomes agitated and growls, but on repeating the demand he at length decides to speak. He pronounces at first feebly and indistinctly, but on telling him to speak more distinctly he gradually finds his voice, and finally pronounces the words demanded very distinctly." This performance, we learn, has been repeated before a great number of persons at Clermont. The same dog, further, if his master has shot and brought home any game, runs of his own accord to the kitchen to seek a knife, carries it to his mistress, and addresses her as *ma maman*.

MM. Gallois and Gory, friends of M. Roujon, state that they have met with several dogs who pronounce distinctly some words—among others the word *non*. It is indisputable, as M. Roujon remarks, that by applying to such animals a methodic selection prodigious results may be obtained. Prof. Max Müller's "Rubicon" may be dried up in a manner plain even to the most prejudiced.—*Journal of Science.*

* A bird of this kind belonging to a contributor of the *Journal of Science* laid two eggs last summer.

† *Revue Internationale des Sciences Biologiques*, 1882. No. 10, p. 348.

THE WINTER SLEEP OF ANIMALS.

To the stroller by field and meadow the transition that comes with autumnal days is peculiarly interesting. The varied forms are preparing for winter. In silken shroud the future moth is laid away. Beneath the sod, beetles, worms, and slugs have met in common sympathy. In the pond the noisome frog, in compact ball, awaits the call of spring, while under the bark and roots of every tree and bush insect forms have found their seasonable home. In cherry stones, tightly coiled, is found the homely sow-bug, its door, the work of some hungry squirrel, thatched and plastered from within. The old yew log, that cheers some winter night, is tunneled with halls, passages, and wards, unsuspected from without, packed with sleeping ants, who, in the vain hope that spring has come, surge out in bold array. The silvery globes with perfect lids, that cling to autumn leaves, bear amid their golden floss the eggs of some garden spider. The bats, unable to follow their feathered friends to milder climes, bereft of food, betake themselves to sleep, and in some cave hang in clustered groups until the approach of spring. The long winter days are passed in sleep so deep that it might be aptly termed a living death, so complete is the respiratory suspension. The most delicate experiments made upon the dormant creatures often fail to betray the slightest movement. The wing extended shows the flowing blood, but the index of the delicate instrument records no answering beat. Even the surrounding air indicates no sign of inhalation, yet the slightest noise brings back its dormant life and in a single hour over four cubic ounces of oxygen are consumed.

THE BAT.

Late in the fall the bats disappear, grouping in most fantastic shapes, a single one often bearing a score or more fellow sleepers. The temperature of the bat slowly adapts itself to that which surrounds it. Their power of will over their muscular organization is completely lost, and the amount of respiration is inversely as the degree of irritability of the muscular fiber. Many of the vital functions enter upon a state of abeyance, and through the long months the food supply comes from the store of fat accumulated during the period of wakefulness, the creature hanging a willing victim to suspended animation. The minute infusoria, whose world may be a drop of dew, are effected similarly; as the water about them grows colder, the rhythmical contractions of their contractile vesicles grow less and less. At 15° (Centigrade) we may count fifteen pulsations, while, when a temperature of 5° above freezing is attained, they are reduced to seven a minute, and at 2° all motions cease. The delicate cilia no longer lash the water, the animal being in a winter sleep, from which it can be aroused by a gentle application of heat to the surrounding water. These and the higher hibernating animals are not as a rule invulnerable to the effects of cold, though many fishes and reptiles have been resuscitated after complete freezing. The effect of an extreme in the higher animals is to awaken them from the peculiar physiological condition in which they seem balanced in the scale of life and death, the latter then ensuing from freezing in a natural way. The limitations of the different sleepers are, however, widely at variance. While some are easily awakened by a falling temperature, the zizel assumes a rate exactly in accord with that without. In some experiments made by an eminent naturalist the temperature of the room in which the animal was kept was slowly lowered until it reached 2° (Centigrade) above zero, or freezing, that of the animal corresponding, showing that during hibernation the warm blooded zizel had become truly cold blooded. As excessive cold is not the immediate cause of winter sleep, neither is a rise in the temperature immediately productive of wakefulness. In one experiment with the animal it awoke in the same temperature in which it had slept for many previous days. Once having been aroused by some yet unknown cause, the temperature of the animal increased with extreme rapidity.

THE SNAIL.

Who has not watched in summer days the glistening throng of snails upon the banks of streams? From the bridge at low tide the muddy flat scintillates and gleams as if flecked with diamonds as the shells move in close pursuit behind the outgoing tide, the march reversing as it rises; a continual coursing back and forth being carried on throughout the summer. But the first cold wind causes a perceptible diminution of their numbers, and frost finds the vast population of the shore far below the surface in winter sleep. They do not assimilate food—in other words, eat, digest or grow—until the reanimating temperature of 15° C., or thereabout, comes again. The molluska are perhaps the most remarkable for the long continuance of this condition. The land snails during winter close their shells with a calcareous plate or epiphragm, leaving a small orifice for breathing, and buried in the earth, remain in a quiescent state for periods of long duration. It is in this condition, or immediately after the formation of the white epiphragm, that the edible snails about Paris are most esteemed. In the British Museum are certain shells that were brought from Egypt and thoughtlessly gummed to a stand, and four years later were found alive by the curator. They were not at all affected by their long sleep, and lived for several years after. Their pulsation, that at the time of capture was 110, during hibernation was not distinguishable. Many of the fresh water mussels retreat to the deep mud and sleep throughout the winter, and the same may be true of salt water forms.

THE HEDGEHOG.

The witch in "Macbeth," according to whom

"Thrice and once the hedgepig whin'd,"

must have heard the little animals when awakened from their sleep; this, some writers say, being the only time in which the peculiar utterance is heard, while others, who have disturbed

the sleeper, aver that its only response is a sigh, the hedgehog immediately relapsing into somnolency that is, perhaps, the most perfect hibernation known among quadrupeds; many of its congeners laying up winter stores, while the hedgehog depends entirely upon the suspension of its faculties. This has been doubted, as apples have been found in the winter burrow, but their presence there may be explained in another way. In the fall the spinous little creatures, warned by the cooler nights, bethinks themselves of the winter and prepare their habitation for it. This may be under the roots of some aged tree, or in a hollow of the same, or even in the burrow of some luckless rabbit, into which bits of hay, grass, or soft leaves are carried. Perhaps upon the last tour the hedgehog essays a stone wall; to ascend is a comparatively easy matter, but the descent would seem a more difficult feat. The little creature, however, with a quick movement leaps into the air, coiling into a ball as it falls, striking upon the mass of sharp spines in perfect safety, uncoiling and passing on, bearing upon its spines the fallen pippin that has chanced to become impaled in the fall. Observers who have witnessed this occurrence assume that the animal impales them purposely as an economic measure; we are, however, inclined to the accidental phase of the incident. Be it as it may, the hedgehog is often seen in the autumn bearing away perched upon its back the fallen fruit. Once within their nest, the animal does not awake until spring, unless extreme cold arouses them. If decapitated in this condition, before the animal can awake, the heart beats on for some time as if its work had not been interfered with. Remove now the brain, even take out the spinal column and sever the various muscles, and yet the heart beats on for several hours, while for nearly a day will it show signs of vitality. How little the creature depends upon respiration can be shown by surrounding it with gas, carbonic acid, etc., and for a long time their effects upon the animal, that in its normal state would be instantaneous, are not perceptible.

THE BEARS.

Many of the bears are winter sleepers, and are often captured by well known marks upon the snow, recognized by the sportsman. Like the hedgehog, the bear depends entirely upon its accumulation of fat, and during the fall is in prime condition, when, in October or November, it enters upon its winter home. One these nests of the black bear, found by the writer several miles from Lake Utowana, in the Adirondacks, was beneath a huge tree, four or five of whose great roots branched out on each side. The earth had been removed on the south side, the interior lined with leaves, twigs, and other refuse matter that would make a comfortable bed; and, covered with snow in a dense jungle, the animal had perfect security. Soon after the bear has retired the intestines shrink and become clogged or hardened with a substance known as tappan, in reality pine leaves and the bark of fir trees that they eat immediately prior to entering upon the state of hibernation, that remains in position until spring, and so slow is the exhaustion of fat, that is now the food-supply, that animals have been found five months after their involuntary entombment as fat as when they went in. During the sleep the skin upon the balls of the feet is renewed. The males of the polar bear do not hibernate, a fact proved by the late polar expedition of the yacht Eira. According to Mr. Leigh Smith, they did not see a female bear from October to March 13. The winter home is merely a shelter in the lee of some rock, the bear allowing herself to be snowed in. Here the young are born before spring, their additional respiration serving to enlarge the snowy house, from which they emerge in early spring, the mother well worn by her attempts at sustaining a family under what would appear exceedingly adverse circumstances.

SOUTHERN ANIMALS.

The badger, dormouse, porcupine, hamster, and many others enter more or less into this strange condition, while the cases of partial hibernation are extremely common, hares having been found buried in the snow for weeks, and even sheep have shared the same fate without injury. The dormouse erects its winter home of various grasses four or five feet from the ground, and so skillfully are they interwoven and joined together that the closest discernment is necessary to distinguish the entrance—that, indeed is only known to the animal itself. Soft mosses line the home, among which the sleepers lie until early spring, often awaking while snow is yet upon the ground. From now until warmer days they merely sleep, awaking from time to time to feed from a store of nuts laid up for the occasion. In the southern countries, where the intense heat is as fatal to animal life as the lowering temperature of the far north or south, a similar condition is entered into by many animals, known as æstivation. In collecting about Bahia Blanca, in September, Drawin unearthed spiders, lizards, and toads, all in a lethargic condition. A week later they began to appear of their own accord, and three days before the equinox all nature was prepared to greet it. On the days not immediately preceding this awakening, the temperature, as recorded by this eminent naturalist, rarely rose above 15°, but in the eleven days preceding it there was a mean of 58°, showing that æstivation is not wholly the result of a change of temperature, but is dependent upon the occurrence of drought. Many alligators and crocodiles pass the dry periods in a similar manner. The mud cases of the marsh crocodile are often found in Ceylon, and have been taken out perfect casts of the animal, telling the story of its hibernation. This habit of the crocodile has been the cause in various countries, especially Ceylon, of ludicrous incidents. In one, an English officer had retired to his tent, which suddenly rose in air, with all its furniture, out of the wreck of which appeared an awakened crocodile that was here hibernating, the fire built without having, perhaps, disturbed its repose, to the astonishment and confusion of the campers out. The yellow snake of Jamaica, that attains a length of twenty feet, excavates a burrow for purposes of partial hibernation, while our snakes of the north are well known to pass the entire winter in the deepest sleep. Among the vertebrate sleepers of the south is found the tanrec of Madagascar, that, burrowed in the sand, sleeps away three months of the year. With hardly an exception, the molluska of the Mediterranean provinces lie dormant throughout the summer. Many fishes are perfect hibernators, lying in the mud during the cold season, or, in the south, passing the season of drought in sun-baked cases, in almost perfect sleep. Not only during one season is this kept up, but several; and, in India, ponds that have been dry for extended periods, when filled, were, as if by magic, populated with the awakened finny sleepers.

Are not our trees in winter sleeping? The sap has ceased to flow, their growth has stopped, and all their functions are at rest. Seeds lie dormant for years. Corn taken from the Aztec tombs has been awakened (?) in the present decade, a process analogous to the awakening of animal life from summer or winter sleep.—*C. H. F., in Evening Post.*

THE LIGNIFIED SNAKE OF BRAZIL.

At the meeting of the Biological Society of Washington, December 23d last, Prof. C V. Riley read a paper on this curious *lusus naturæ* which is now being discussed by scientists in this country. The following is the substance of his remarks:

In *La Nature* of the 6th of May last [reproduced in SCIENTIFIC AMERICAN SUPPLEMENT, No. 345] M. Louis Olivier gives an account of "Le Reptile lignifié de Matto-Grosso"—an object which has attracted more or less attention from the scientific world of late. The specimen was found in the province of Matto-Grosso, Northern Brazil, and after obtaining many contradictory opinions from members of the scientific societies at Rio Janeiro, its present possessor—Senor Lopes-Netto, Envoy Extraordinary and Minister Plenipotentiary from Brazil to the United States—took it to Paris with him and submitted it to M. Olivier, who afterward brought his results before the Societe Botanique. The article embodies the result of his examination. The object is, in brief, what appears to be a lignified serpent formed between the outer bark and the wood—in the *cambium layer*, in fact of a native tree known as the *Ipê mirim*.

M. Olivier states that to the eyes of his associates and himself, it is evident that the object is not due to the intervention of the hand of man. The head and neck and other parts of the body are beautifully shown. In certain parts of the body the most delicate parts of the animal organism are said to be plainly visible—the nasal apertures, the orbits of the eyes, and upon a portion of the head the disposition of the scales and cephalic plates is distinguishable. He even goes so far as to identify the serpent as the little *Jararaca* of Brazil.

In explanation of this wonderful state of affairs, he starts with the statement that it is *necessary* to admit that the live serpent worked its way into the position it occupied when found. An anatomical examination showed that the whole animal is completely lignified, except at the center, where some constituent animal elements still remain. His examination showed that it is made up of cellules and fibers similar to the fibers and cellules of the wood which surrounds it. It is impossible, he states, that this appearance could be accounted for on the hypothesis that this formation had taken place in a channel which had been traversed by the serpent, retaining its form; for upon the piece of wood not only is the contour of the animal recognizable, but also its entire body in relief. Beyond the head is seen, also in relief, a little cylinder which M. Olivier supposes to be an insect larva which the reptile had followed into a fissure between the bark and the wood, where after a number of years it had been covered by a series of woody layers and the cellules and fibers of the cambium layer had been substituted for the constituent parts of the animal's periphery, the surrounding zones becoming more or less hypertrophied, leaving the body in relief.

The members of the Botanical Society present at the meeting of April 9th, agreed with M. Olivier in this conclusion; but in closing his article he admits that there is still room for doubt, and that he will postpone a definite decision until he learns the result of the examinations by the scientific men of Italy, Sweden, and the United States, to whom Senor Netto proposes to submit "ce reptile énigmatique."

The main points of this article were repeated in the *Popular Science Monthly* for November, 1882, with a letter from M. Olivier to Senor Netto, giving the additional testimony of MM Siegher, Edmond Bonnet, and Dr. Adanson. The conclusions, are, however, here stated as facts with less qualification.

Senor Netto deserves great credit for the efforts he has made to get at a satisfactory explanation of the strange specimen in his possession—efforts which show that he desires to get at the truth; and it is not surprising that with such testimony and opinion as that above given he should himself be a strong believer in the lignified snake theory. I propose to show, however, that there is a far more rational explanation of the phenomenon.

There are on record various curious instances of similar erroneous conclusions that have been arrived at in the past from the chance and striking resemblances which galls and fungi at times bear to fruits and animals. I have an oil painting of a fungus found on a prostrate log which so remarkably resembled an unfledged chicken that it was deemed fit for preservation in this form by a prominent lady member of the Alton (Ill.) Horticultural Society, who made the faithful painting some fifteen years ago; and I have called attention (5th Mo. Ent. Rep., p 114 *ff*) to the frequency with which certain galls are reported as hybrids between different fruits. The last instance of this kind that reached me was the following letter addressed to Professor Baird, the supposed hybrid between a grape-vine and a pecan being in reality the gall of *Cecidomyia vitis-pomum*:

AUSTIN, Texas, July 15, 1882.

SPENCER BAIRD, Esq., Secretary Smithsonian:

Dear Sir: I this day transmit what seems to me to be a very unusual vegetable production. It is that of the fruit of a mustang grape-vine, very distinctly hybridized by contact with the pecan tree about which the parent vine twines for support. I have never observed the phenomenon before, nor have I ever heard of its coming under the observation of any one else. The inclosed clipping from the vine on which the abnormal growth was found was brought to me by I. V. Davis, Esq., whose home is just over the river from Austin, and who lately found the parent vine growing on his farm. He says that the vine had produced only a very few grapes, and all were of the same nature with that of the specimens I now inclose to you. Only two now remain upon the vine.

Yours respectfully,

J. H. HUTCHINS.

I also exhibit, in illustration, a mesquite bough which had naturally grown so like a serpent that it has hung for some time in Professor Baird's office as a curiosity, and which exemplifies the temptation that exists under such circumstances to exaggerate the likeness, on the part of the discoverer, in some artificial carving at one end that enhances the likeness to a serpent's head.

Upon first being shown the original of the "lignified snake" by Senor Netto, at his residence, I was at once struck with its resemblance to a burrow of some Coleopterous larvæ of the family *Buprestidæ*, filled as such burrows customarily are with excrement and rejectamentary fibers. Subsequent careful examination and consideration convinced me that such an explanation is far more plausible than that hitherto proposed. I consider that this explanation must have forced itself upon the French savants who studied the specimen, had there been any entomologist among them. My views may be summed up as follows:

1. It requires a great stretch of the imagination to consider the object in advance of the so-called reptile's head an insect larva. To an unimaginative eye it appears like a simple knot, similar in all respects to two which occur in other parts of the "serpent" itself.

2. The length of the object—28 cm.—in comparison with its width—1·5 cm.—is also significant when the fact is considered that at the point where the piece ends the diameter of the "serpent" is greatest. This would correspond with the gradually increasing size of a larva which has entered at the smaller or head end of the "serpent." It is significant also that the larger end, where the insect would have prepared for its transformations and exit, is broken off, and that the first curve which, on the serpent theory, the animal must have made in forcing its way under the bark is so abrupt and the relief so doubled upon itself that any such bend of a snake without breakage of the vertebræ were practically impossible.

3. The cephalic plates and scales exist wholly in the imagination of the describer. Nothing which can be homologized with either is to be seen in the specimen.

4. The tortuous course which the object takes, while perfectly natural in the burrow of a larva, is unnatural for a reptile forcing itself into so confined a space. The woody formation that has tended to form over the serpentine relief and to conform to its curves on the natural surface of the wood indicates a burrow beneath the liber, and not the forcing of an animal or other object between the bark and wood, since such forcing would have loosened the bark for some distance on either side of the relief. Moreover, I consider such sudden forcing of an animal between the bark and hard wood of any tree a physical impossibility except where the bark is already loosened, a supposition that involves the idea of death or decay in the tree and consequent incapacity to renew tissue.

5. The granular appearance to be seen along the sides of the specimen, as well as the fibers observable, are just such as an insect larva would leave, and cannot be accounted for on M. Olivier's hypothesis.

6. The presence of animal matter in the center of the body is not at all incompatible with this theory, as the exuviæ, as also the excrement of the larva, would exist among the *debris* and contain some animal matter.

7. A critical examination shows some human handiwork, and that the temptation, on the part of the discoverer, to heighten the resemblance of a snake was not resisted. This is shown about the head and especially in the eyes· while the same tendency to exaggerate in the same direction is noticeable in the engraver's work on the illustrations, especially of the tail end.

8. The whole question could be readily settled by a careful section, for upon the serpent hypothesis not only should traces of the vertebræ appear, but in any event traces of phosphate of calcium ought to be found upon chemical analysis along the line of the vertebral column. But Senor Netto has, so far, objected to any mutilation of the specimen.

THE FISHERIES OF JAPAN.

CONSUL SMITH, of Nagasaki, says that the fisheries of Japan constitute one of the most important industries of the country, and that an approximate idea of the extent of the business, and the number of people engaged in it, may be formed, when it is considered that the population of Japan is about 35,000,000, and fish is the chief article of food which enters into the consumption of every Japanese household, and a very large trade also is carried on in preparing and exporting dried fish to China. In the district of Nagasaki alone, there are nearly 70,000 persons, of both sexes, engaged exclusively in the business of the fisheries, whose annual receipts, for the sale of fresh fish, amount to over £1,000,000. The fisherman's boat is generally from twenty to thirty feet in length, and proportionately wide, and is constructed of light, strong wood, and propelled with great rapidity. Sculling is the method universally used among the Japanese. The oar or scull consists of two pieces, one joined to the other, overlapping about the middle. On the handle is a pin, on which a rope is slipped, so that the oar is held down to a uniform height while being worked. The blade is flat and long, and rests, near where it joins the stock, on a pivot; the sweep of the stock, at the hand, is about three feet. The same model of boat, but smaller in size, and of neater construction and finish, some with a little cabin in the fore-part, called "house boats," are used everywhere in the waters of Japan, under the general name of "sanpan." The larger fishing boats, called "kotsufuni," are made to carry from thirty to forty men; they are propelled both by sculls and bamboo sails, and are used in catching deep sea fish, the albicore, and the bonita; the former is a fish from four to six feet in length, and weighs from 150 to 200 pounds; the latter weighs from ten to twenty pounds. Both these fish are caught with hook and line, and often in the seine. The smaller fishing boats are constructed with a division in the center, with openings for the water to enter, in which the fish are kept alive. Much of the fishing is done in the night time, when the torches of the fishermen light up the sea. The fish are attracted by the light, and are speared from the boat's sides, as well as taken by the hook. The greater portion, and especially the smaller and most common varieties, are taken in stationary nets, in comparatively shallow water, from ten to twenty fathoms deep; some of the nets used will cover an acre of surface; they are in the shape of a triangle, the finest meshes are at the apex, and gradually enlarge as they extend toward the base. The apex is held in place by a buoy composed of bamboo poles, and bunches of these are also placed at intervals along the sides and across the base of the net. The center of the net falls to the bottom, while the large meshes at the outer side permit fish of all sizes to enter. When it is desired to make a haul, boats pass along the base, and the net is gradually gathered up as they near the apex. In this way the fish are driven into the finer part, where they are secured by dip nets. The large net is at no time taken into the boats, but passed under the bottom as they approach the buoy, and at the end is ready set for another haul. The other seines used by the Japanese do not differ in any material degree from those used on the Atlantic coast. The larger and rarer kinds of fish are taken by the hook. The common and coarse flesh fish, such as sharks, skates, and mackerel, are very abundant in Japanese waters, and are largely consumed by the poorer classes. Young sharks are highly esteemed by the natives. The most valuable of all the food fish is a sea bream, which is known in Japan as the "tai." A species of sardine, of excellent quality, is found here also in great abundance, and is used in a dried as well as in a fresh state. To take them two boats usually go out together, under sail before the wind with a line from each boat, holding the net between them; when the catch is made, the boats approach each other, and the net is drawn up. They are

preserved alive for market, in bamboo baskets sunk in the water. Salmon are caught in great abundance in the northern part of Japan, in the neighborhood of Hakodate, where a large river empties into the sea. The fishery at the mouth of this river is said to yield, annually, about £12,500 in salmon and other fish. The fishing season there is in September and October, and the nets used are, some of them, 400 feet long by 40 feet deep, and require about seventy men to haul them. Ten thousand salmon have been caught at one haul of the seine; smaller nets, in poor seasons, take 700 and 800 salmon in a day, in fact, so plentiful is this fish in many parts of Japan, that fish manure is an article of standard manufacture, sale, and use. In April and May, many whales are taken near Hirado and the Goto Islands. During these months, the whales are passing to the northward, and linger in the vicinity of Nagasaki, on account of the fishing grounds. When a whale is discovered, from six to twenty boats put off in pursuit; some of them spread a vast net in front of it, while the others attack with harpoons and lances, the former being thrown high in the air, and coming down with the barbed point into the flesh. The flesh of the whale is esteemed a great luxury by the natives, and brings the highest price in the markets. Nearly every kind of fish is eaten by the Japanese, and the multitude and variety of the choicest edible fish are remarkable. The markets are places of curious interest, and show many strange species, from the beautiful flying fish to the shark and devil fish. In the early days, it was customary to eat live fish, and even now there are certain choice fish which, when the seines are drawn, the women cut open and devour while still alive.

NOTES ON ACCLIMATION OF THE BAMBOO, YAK, ETC., IN THE UNITED STATES.

AT the request of Consul-General Denny, Dr. Macgowan has forwarded through Vice-Consul-General Cheshire, for acclimation in the United States, several plants, with the following accompanying notes:

"That botanical anomaly, the square bamboo, which I have elsewhere described, will not strike you as particularly remarkable, inasmuch as the specimens sent are young, such only being transplantable; their perfect squareness is not attained until they mature in their third year, when they measure over an inch each way, forming substantial canes. More useful is the black bamboo, which I also send. It is employed in making articles of furniture. As regards utility, however, the inducement for acclimatizing those varieties of the bamboo (there are above a hundred) is not great; they are merely ornamental. What our country needs from the bamboo family is the kind called *moa chu*, "hairy bamboo," which has a wide geographical range, extending northward to regions that have, to a slight degree, snowy and icy winters; conditions for its profitable culture doubtless exist in various portions of the South. Its value in the arts is sufficiently well known, but its excellence as an article of food (its shoots) is not generally understood. Concerning its plastic treatment for carving I have already written.

"The *Chamaerops excelsa*, or coir palm the most hardy of the family, ought to succeed in any portion of the Union where the winter's cold does not fall below 31°. The utility of its bracts for ropes, mats, etc., is too well known to call for elucidation. I send, besides, another sub-tropical tree which also thrives on this coast a little above the twenty-eighth parallel of latitude, the pseudo-banian (*Ficus pyrifolia*). It will be found in the collection, and some of its seeds as well. The citizen who first succeeds in the culture of this most umbrageous and magnificent tree will confer a boon on the men of the twentieth and centuries following, that must afford satisfaction in contemplating.

"I have obtained seeds of the remarkable turnip of which I sent specimens, but I find that they were gathered too late; in the spring I shall try again, and be in time for next autumn's planting. The discoid shape—being conical disks of from five to eight inches in diameter—is the result produced by undermining the plant at an early stage of its growth and paring off the outer radicles. It is called from its figure the platter turnip, and is the best flavored of its kind. The limit of its cultivation is restricted to an extremely limited area, and few places in this country being adapted for its growth, experiments would probably have to be tried before suitable conditions could be found at home for its successful cultivation.

"I commend the matgrass herewith transmitted. There must be many regions where it should be acclimatized, thus rendering unnecessary the importation of matting from this country. Probably it would thrive in the tule lands of California, and certainly in the rice regions of the Atlantic coast. Besides being used for mats, this grass is largely employed in shoemaking. I inclose specimens of straw shoes which cost from a cent and a half a pair to ten cents, for deposit in the Museum of the Agricultural Bureau, Washington. Shoes of this description might be found useful among the laboring population of the South. The soles of the inferior kind are made of rice straw, those that are of stronger make have a sort of tule grass for soles; the uppers in all kinds being composed of mat and tule grasses interwoven, the former forming the web, the latter the woof.

"Although Chinese rice is inferior to American I send specimens of two varieties, the red and the glutinous. The former is coarser and more productive than the white variety, and consequently cheaper. It is much used by the poor, being as nutritious as the dearer article. Glutinous rice is employed for cakes and confectionery, but chiefly for brewed and distilled liquors, the flavor of which, however, is so unattractive that this rice is not likely to be turned to a baleful account.

"The toothsome and wholesome bitter orange of this region would prove an invaluable acquisition, but mere private enterprise is hardly adequate to the undertaking of its acclimation, and I must fain stop here.

"Many years ago I called attention to the desirability of acclimatizing the yak in the cold regions of the Union. That the animal would thrive in elevated portions of the North is evident from the success that has attended its acclimation in France, although not from an industrial point of view. It could be profitable only where winters are too severe for the domestic cow to flourish. The yak or "grunting ox." *boephagus* (*Bos grunniens*) endures cold like the reindeer, and ascends acclivities with almost goat like agility carrying over two hundredweight; it yields superior milk for butter and cheese, its hair is valuable for textile purposes, its tail for chouries, while its hide is in demand for leather. Its flesh is of the finest quality, that of the calves being superior to veal. Moreover, this "grunting ox" and the domestic cow afford a useful cross breed. Does not this subject merit attention on the part of the general Government?

"D. J. MACGOWAN.

"Wenchow, 6th December, 1882."

LARGE-ROOTED CHICCORY.

THIS is a variety of the common chiccory, and although but little grown in this country, it is cultivated on an extensive scale in some parts of France for the sake of the roots, from which is manufactured the chiccory of commerce. It is also grown by some of the Parisian market gardeners, as the blanched tops which it produces in winter are of rather finer appearance than those obtained from the typical form. I would advise those who make a practice of forcing chiccory to give the large-rooted variety a trial. It requires the same general treatment as the ordinary kind, but when thinned out should have more space for development. It is best to sow the seed in rows one foot apart, allowing a space of from six inches to eight inches (according to the character of the soil) from plant to plant. Do not sow before May, or the plants will run to seed. Give them an open position and cleanly culture, and large, well-matured roots will be obtained; these, if placed during winter in a warm, dark place, will furnish an abundance of crisp blanched leaves, which will be found a very acceptable addition to the usual run of winter salads.—*J. C. B., in The Garden.*

LARGE-ROOTED CHICCORY.

A GRACEFUL TRAILER.

PLANTED out at one end of an old-fashioned cold greenhouse we have a plant which we call—I know not for certain if quite rightly—Smilax tamnoides; it is a general favorite, especially just now, when its glossy leafage looks even more beautiful than at any ther season, owing to its being seen in contrast with its elegant racemes of sweet, white flowers. Although an old-established plant in our garden, few know what it is, but it is nevertheless admired by all for its peculiarly distinct and effective character and extreme grace of habit. We are always glad of its graceful sprays of deep green leaves, which may at all times be obtained in plenty, and their great powers of endurance, when cut, add much to their usefulness as indoor ornaments or for associating with cut flowers in drawing-room vases. The spray here figured is quite a short one, but it well shows the distinct habit of growth and peculiar form of inflorescence. Although but rarely seen in gardens, this pretty evergreen well deserves culture; indeed, culture is scarcely needed—it seems grateful for a corner and a little moist soil anywhere.—*The Garden.*

FLOWERING SPRAY OF SMILAX TAMNOIDES.

CALIFORNIA QUICKSILVER.

GENERAL ROSECRANS, of California, filed a statement before the House Committee of Ways and Means, December 27, showing that during thirty-three years the California quicksilver mines have produced 1,310,095 flasks of quicksilver, or 100,222,267 pounds. There was, during the same period, 881,017 flasks, or 67,397,800 pounds exported, or two-thirds of the product, which was valued at $47,582,843. California produces one-half of the quicksilver in use throughout the world, the most of it being mined by small capitalists. These come in competition with the Rothschilds, who control the quicksilver mines of Austria and Spain. According to General Rosecrans' statement, the Rothschilds got control of the greater part mined in 1873, and ran the price up to $1.20 per pound. In 1875 they did the same, running the price up to $1.55 per pound. The Rothschilds now have control of one hundred thousand flasks, and have run the price down to thirty-nine cents per pound.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
261 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—Apparatus for Regulating Pressure in Water Conduits.—2 figures ... 5931
The "Cascade" Saturator.—2 figures ... 5931
Improved Ball Valve.—2 figures ... 5931
Protecting Iron and Steel from Oxidation or Rust ... 5931
Improved Dynamometer.—2 figures.—Ayrton & Perry's dynamometer ... 5931
The Cursometer.—1 figure ... 5932
Superheated Steam.—By S. N. CARROL ... 5932
Aerial Navigation. By F. BARNET ... 5932
The Sinking of the Austral.—1 figure.—Sinking of the Orient steamer Austral in Sydney Harbor ... 5933
The Tunnel between France and England ... 5933

II. TECHNOLOGY AND CHEMISTRY.—Straw Plaiting and Weaving in Tuscany ... 5926
Flexible Tissue for Dark Room Windows ... 5936
On Teaching Organic Chemistry. By Prof. EDWARD J. HALLOCK ... 5936
Antiseptic Properties of Carbonic Acid ... 5937
Zinc in Sulphur ... 5937
Testing for Iodoform, Naphthol, and Chloroform in Animal Substances ... 5937
Chemical Theory of Gunpowder ... 5937
Removal of Fixed Glass Stoppers ... 5938
California Quicksilver ... 5940

III. HYGIENE, MEDICINE, ETC.—Naphthalin as a Wound Dressing. By Dr. G. R. FOWLER ... 5938
Unconscious Brain Work ... 5938
Sassafras in Rhus Poisoning ... 5938
Pasteur on Hydrophobia ... 5938
The Brain—Weight of Gambetta ... 5939
The Three-Headed Woman.—3 figures.—Showing how the trick is performed ... 5939

IV. NATURAL HISTORY.—Speech in Animals ... 5940
Winter Sleep of Animals.—The bat.—The snail.—The hedgehog.—The bees.—Southern animals ... 5941
The Lignified Snake of Brazil ... 5941
The Fisheries of Japan ... 5941
Notes on Acclimation of the Bamboo, Yak, etc., in the United States ... 5942
Large Rooted Chiccory.—1 figure ... 5943
A Graceful Trailer.—1 figure ... 5943

V. ELECTRICITY, ETC.—New Telegraph Sounders.—2 figures.—Bright's improved telegraph sounders ... 5939
Electricity the Propelling Power of the Universe. By L. E. WOODWARD ... 5939

VI. ASTRONOMY, METEOROLOGY, ETC.—Theories Regarding Polar Auroras.—Cosmic theories.—Optical theories.—Magnetic theories.—Electric theories.—5 large Illustrations.—The aurora borealis as observed at Bossekop in 1869, and at Noutato, Alaska, by MR. WHYMPER ... 5937
Photographing the Solar Corona without an Eclipse. By W. HUGGINS ... 5940

VII. ARCHITECTURE, ETC.—The Decay of Building Stones ... 5934
Gregynog Hall, Montgomeryshire.—1 figure ... 5934
Recent Fires and their Lessons ... 5934

PATENTS.

In connection with the **Scientific American,** Messrs MUNN & Co. are Solicitors of American and Foreign Patents, have had 38 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 261 Broadway, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.